POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884

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Volume 71 NEW YORK, FEBRUARY 4, 1930 *Number 5*

Steam Boiler Inspection

THOSE States and cities that are alive to the danger of allowing anyone to put in any old boiler that he may pick up and run it at any pressure that he pleases have worked out a system of unification and co-operation that has great possibilities.

The American Society of Mechanical Engineers maintains a Boiler Code Committee which has formulated rules for the safe construction and operation of boilers and other pressure vessels.

Most of the departments established by states and municipalities for the supervision of such vessels have adopted the specifications of this committee as the standard to which they require them to be built and installed.

The head of each of these bureaus or departments is a conferring member of the committee, free to attend its meetings, take part in its discussions and advise in the making of its interpretations and revisions.

These heads of departments have a national organization at the annual convention. They compare experiences and statistics, discuss the greatest menaces to safety and unify their ideas and practices.

The possibilities of this combined system in bringing to bear upon the problems of materials, design, allowable stresses, etc., the minds of the best experts in the profession; the organization of a corps of inspectors informed as to the reasons of the restrictions adopted, qualified to intelligently enforce them and skilled in detecting incipient failure to which any boiler is subject in reducing the loss of life and property through boiler explosions are apparent.

But there are other possibilities: The avoidance of the confusion that would result if each state or city had a different set of requirements, especially to those who build boilers for stock or move equipment from place to place. The possibility of a record of all major explosions with analyses of their causes. The possibility of statistics as to the number, size, type, length of service, etc., of the boilers in use.

To realize these and other possibilities requires that there should be a high order of men in charge of the inspection departments, men who know boilers from practical contact, who know materials and their vagaries. It is not too much to expect that such positions should develop Fairbairns and Strohmeyers.

But this cannot be unless the appointing powers appreciate the type of service that these men have the chance to render, the high quality of man who is required to serve the public best in these positions and the fact that their effectiveness and value increase with their experience and time spent on the job.

It takes real engineering to supervise a boiler inspection department. The appointment of men to such positions in payment of political debts may be a serious menace to the public safety, and certainly does disorganize an admirable system.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

On Byproduct Power

GREAT MINDS are ever engaged in the fascinating search for more efficient ways to utilize our natural power resources.

Hydraulic power production has reached a high state of development and little margin remains for the attainment of perfection.

The efficient use of heat is far more complex and there is room for vast improvement. True, great strides have been made in late years. Steam turbines are highly efficient. Heat absorption in boilers has advanced. Mechanical firing methods, greater efficiency in station auxiliaries, reduced steam-transmission losses through pipes and valves, have all contributed to the present development.

But potentially greater than any of these is "Better Use of Byproduct Heat and Power"—the fifth principle for which *Power* stands. Therein is one of the most fruitful sources of heat conservation in industry. The general idea of utilizing byproduct heat and power is quite well known, but how to achieve maximum efficiency is a problem for study and concentration worthy of the attention of the foremost engineers.

Then too, equipment should be chosen for its economy of operation; and in this connection proper operating methods are paramount. There is an economic balance between the saving to be effected and the price of the equipment required. Here the project may turn for better or worse.

Moreover, byproduct heat and power utilization offers a fertile field for the application of the sixth of *Power's* principles—"Operating Methods That Save Money."

Jobs, Machines and Power

THE great revolution started by machinery is still under way. Everybody knows this in a general way, but few appreciate the astounding productivity that has been achieved in some plants. Only last week Dr. Julius Klein, Assistant Secretary of Commerce, cited a remarkable example. "In a Middle Western state," he said, "there is today a huge plant which is filled by what is really a single machine. It turns out completed automobile frames almost untouched by human hands. Each frame remains on conveyors nine-tenths of the time. To supervise this vast 'automat' about two hundred men are employed. The plant turns out between seven thousand and nine thousand automobile frames per day.

"A rather well-known automobile plant in Central Europe also has two hundred men in that part of its establishment devoted to this same kind of work. They turn out thirty-five frames per day. The almost incredible efficiency of our new American machinery could scarcely be illustrated in a more striking fashion."

This means thirty-five to forty-five frames per day per man in the American plant, and less than one-fifth of a frame per man in the European plant. The low pay of workmen in Europe, and the high cost of European cars are significantly related to this condition.

Herein lies a tip for the power engineer. As the unfolding of the machine age results in fewer workers per unit of output, and more power per worker, the relative importance of power must increase. This means that industrial executives will more and more direct their attention to the power plant and to the men who operate it. And this, in turn, means greater opportunities for engineers of vision and more rapid retirement for those who fail to keep abreast of technical progress.

The Smoke Problem Can Be Solved

NO LONGER does the local business association point with pride to the smoke belching from the near-by mill chimneys.

So rapid has been the development of betterment programs that nearly all important cities have smoke prevention bureaus and ordinances. Although these activities have already resulted in a clearer sky, better plant efficiency and a better health rate, it is most difficult to prevent a resumption of old-time conditions. Fines are but deterrents and not preventives, for while the fireman may manage to escape violating the fifteen-minute rule, he can and often does pollute the atmosphere. And when the same condition exists above a thousand chimneys the aggregate of the smoke becomes evident.

As revealed in recent meetings of civic bodies in New York City and Baltimore, the greatest violators are the house chimneys. This is not surprising, for firing methods necessary to avoid smoke cannot be followed in a furnace that receives attention two or three times a day.

When criticising the householder, it should be remembered that his individual contribution is small and vastly less than the nuisance created by a single boiler stack. It follows, then, that first attention should be given to the boiler house, where firemen are in constant attendance.

If the smoke is no longer to hang as a mantle over our

cities, firemen must be trained and efficient firing mechanism installed.

For the household furnace a stoker is needed that does not require skill of the tenant. It must be of a type that can be installed with minimum alteration in the boiler, and, finally, it must be cheap.

A large part of the cost of many small stoker installations is in the necessary furnace alterations. These must be eliminated, and fortune will smile upon the engineer who produces a simple apparatus that can be placed in operation by thrusting one end in the furnace and turning on the electrical motor.

A little more engineering, a little more civic pride plus instructions by trained men will solve the smoke nuisance.

Overselling Is a Bad Habit

IN MANY localities district heating companies are fulfilling a definite service of both economic and civic value. Both of these subjects were touched upon in a recent talk before a chapter of the American Society of Heating and Ventilating Engineers.

In addition to the usual claims that central station plants improve cleanliness and reduce the smoke nuisance, it was stated that district heating in one large city eliminated coal and ash trucking from congested business streets to the extent of 1,400 trucks each day for 300 days a year. This may be of civic value and something that the city fathers and motorists are thankful for, but the building owner is not interested in paying for civic improvements in this way.

It is entirely justifiable that he should, after comparing the cost of operating his own boiler plant with the cost of purchased steam, adopt that service which is the more economical.

At the meeting referred to a comparison was given which placed the cost of supplying 87,000,000 pounds of steam per year to a large office building at 77 cents per thousand pounds for district heating steam, and $1.54 per thousand pounds as the cost of generating steam from from a boiler plant in the building. As judged by data available to *Power* these cost figures appear misleading.

Many boiler plants in the locality in question are able to produce 1,000 lb. of steam an hour for 60 cents, including the cost of fuel, labor, maintenance and supplies. Since boiler installations in buildings are frequently expensive, consider a cost of $10 per square feet for installed boiler surface. Apply fixed charges at 13 per cent. These assumptions will increase the cost per thousand pounds of steam generated to about 85 cents. Whether a rental value for the space occupied by the boilers should be added to this steam cost is debatable, since in many cases the space is not in a rentable location.

Although the cost of generated steam appears greater than the cost given for purchased steam, it should be pointed out that this cost of purchased steam is not typical of the average office building in that locality. A cost of 85 to 90 cents per thousand pounds is nearer the average value.

It is unfortunate that such overselling should be attempted when, by presenting the facts, the sound economic value of district heating service can be amply demonstrated in any place where it deserves consideration.

Help Make State Supervision Effective

STATE SUPERVISION of the design, construction and maintenance of dams is a live engineering question of great importance to hydro-electric engineers. Nine states have enacted such legislation and others have similar statutes under consideration. Dam construction is a major item of cost in many water-power developments. Anything that increases this cost unnecessarily makes it more difficult for water-power projects to compete with steam. For this reason hydro-electric engineers have a vital interest in state legislation for supervising these structures.

It is generally recognized that the design and construction of a large dam should never be left to the judgment of one engineer, no matter how skillful he may be. Greater conservatism and sounder judgment is required there than in any other part of the project. A machine failure may be repaired at nominal cost, but failure of a large dam is a catastrophe. Therefore, uncertainty in its location, design, construction and maintenance cannot be tolerated. Although absolute safety is required in dams, to make them unnecessarily strong may so affect the cost of a water-power project as to prevent its development.

Many of the defects that have caused dam failures could have been avoided by effective regulation and control. Such supervision calls for a degree of intelligence and judgment probably not required in any other government regulatory body. In the present state of the art it is doubtful if a code could be established for dam design and construction.

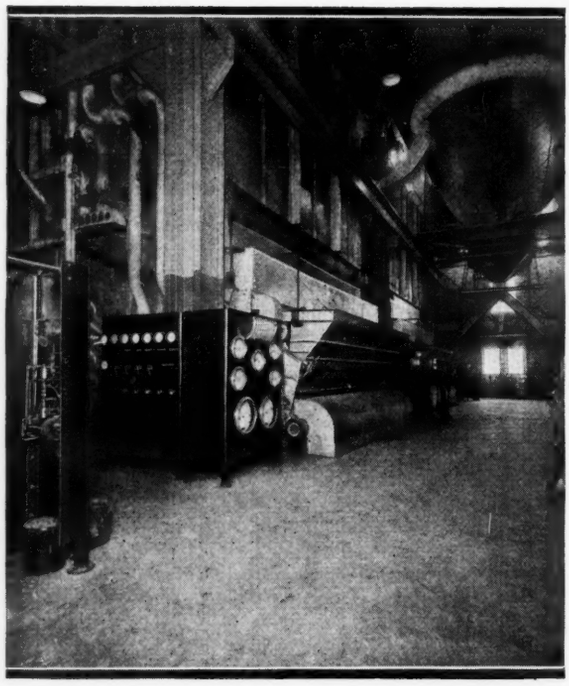
Even if a satisfactory code could be set up for the safe design of dams, the stability of their foundations would still remain a matter of engineering judgment and experience. These problems can be passed upon only by men of the highest technical skill—by leaders in their profession. Serving their state in a supervisory capacity should not prevent these engineers from following their private practice.

State supervision of private operations is generally resented. However, as pointed out at a recent meeting of the Power Division of the American Society of Civil Engineers, control over the design and construction of dams is inevitable. As engineers are best suited by training and experience to determine the best form of regulation, they can well afford the effort to secure it.

Chicago University's New Steam Plant

Provides for Future Power Generation

Complete costs, operating data and guarantees for three 12,040-sq.ft. boilers, equipped with water walls, economizers, air preheaters, forced-draft chain grate stokers, and combustion control. A 5,000-ft. tunnel carries the steam to the campus buildings.



One side of firing aisle, with control board in foreground

SINCE ITS INCEPTION, the University of Chicago has maintained a power plant to generate steam and power. As the demands increased the plant was expanded until limitations in space and obsolescence of equipment made it desirable to erect a new boiler plant at a location favorable for coal delivery and ash disposal by rail. This involved an interconnecting tunnel 5,000 ft. long to carry the steam supply and return piping. On the new site, in a residential district along the Illinois Central tracks, an attractive new boiler house has been erected. The boilers are of 12,040 sq.ft. each and are provided with water walls, forced-draft chain grates, economizers and air preheaters.

Until recently all current for power and lighting had been furnished by engine-driven direct-current generating units in the older plant, with distribution at 230 volts. Owing to the loaded condition of the transmission lines, the drop was excessive and many of the underground cables were in bad condition. With the building of the new Medical Group, a decision was made that in all new buildings and future extensions alternating-current electrical service would be provided and that older buildings would be rewired as promptly as funds were available.

Owing to the failure of two of the old engines, two turbine-driven, geared, direct-current units of 300-kw. capacity each were installed in the old power house to care for the direct-current load until the general distributing alternating-current system had been completed. At present all of the alternating-current service, which comprises approximately one-half of the total electrical load, is purchased.

From a review of plant records over a number of years, the following facts were established for use in determining future steam and electrical loads. The maximum load condition requires 30 lb. of steam per hour to serve 6,000 cu.ft. of building space. The yearly electrical demand is 0.04 kw. per 1,000 cu.ft. of building space, and the electrical energy consumed in a year per 1,000 cu.ft. of building space is 135.6 kw.-hr. From these factors and the probable cubical content of the buildings, the yearly loads up to 1945 given in Table I were computed, and the unit size of equipment for the power plant determined.

Operating at 250 per cent rating, two of the three boilers will carry the present maximum load. Space is provided for an additional unit to care for future growth, and space is available to duplicate the present boiler room. Although the boilers were built for a working pressure of 300 lb., they will be operated for the present at 150 lb., and if new generating equipment is installed, the pressure will be raised to 250 pounds.

A furnace volume of 3,500 cu.ft. has been provided, and at 250 per cent rating the heat release will approximate 30,800 B.t.u. per cubic foot. The stokers are forced-draft chain-grate, 21 ft. wide, with 280 sq.ft. of effective area, which bears a ratio of 1 to 43 to the steam-making surface. Each stoker is operated by a motor through a variable-speed transmission which is regulated by the combustion control. At each side wall sixteen 4-in. vertical tubes protect the brickwork

and add 162 sq,ft. of heating surface per boiler. The combustion arch is of the concave-convex type. Siftings from the front of the stoker are chuted to the basement for delivery to an industrial car and eventually are returned to the bunker through the coal-handling system. Stoker ash and economizer soot discharge into the ashpit at the rear, thence into industrial cars, which are emptied into the lower run of the continuous-bucket coal conveyor. Delivery is made to a pan conveyor leading to an overhead storage bin, the latter discharging to the railway cars bringing in the coal.

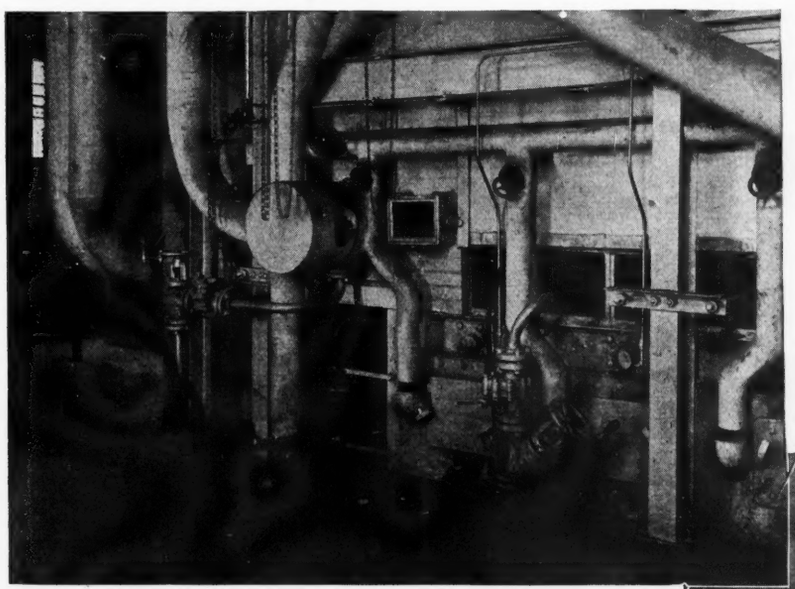
Convection superheaters provide 150 deg. of superheat. The economizers have 28 per cent as much surface as the boilers and the plate-type air preheaters 83 per cent. Air is drawn from the upper part of the boiler room by double-inlet turbine-driven forced-draft fans, and discharged through the air preheater to the air compartment below the forced-draft chain grate. A branch connection provides overfire air.

Two induced-draft fans units serve each stack. They are driven by 100-hp. steam turbines through reduction gearing,

five cars of coal being dumped at one time. Ashes may be delivered directly into these cars from the overhead storage bin. There is space for 1,500 tons of coal in the overhead bunker, and an additional 4,500 tons may be stored in the yard.

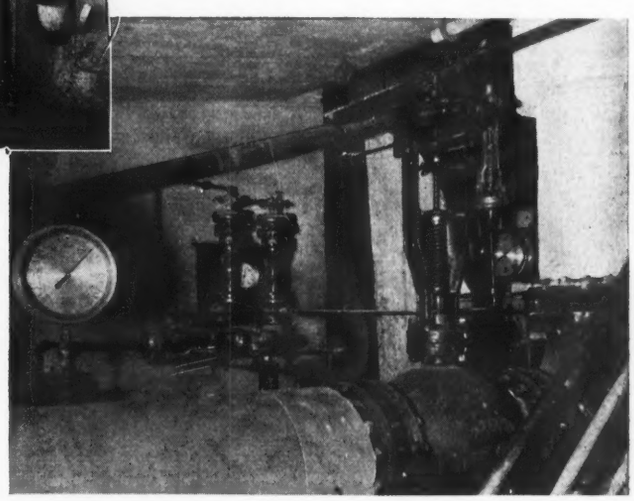
A conveyor tunnel runs under the trestle. Through hand-operated gates in the tunnel roof the coal from the cars is fed to a belt conveyor by a movable automatic feeder mounted on rails so that it may be shifted to any desired opening. A lateral pan conveyor transfers the coal to the crusher, which makes delivery to a pivoted bucket conveyor carrying the coal to the top of the building. A transverse belt conveyor with automatic tripper delivers the coal to the bunker, and a 10-ton traveling weigh larry transfers the coal from the bunker to the stoker hoppers.

As the new boiler installation has been designed primarily as a heating plant, one of the most important considerations was to provide for a proper method of handling the condensate return and the make-up water. A series of tests indicated that the oxygen content in the general return system from the university varied



Side view of boiler, showing water-back and side-wall blow-off valves and stoker compartment soot blowers

Pilot operated reducing valves at power plant entrance to tunnel



Detail data on the foregoing equipment appear in an accompanying table. To check the performance guarantees for the superheater, economizer and air preheater, a five-hour test was made. Readings taken every fifteen minutes are averaged in Table II. With the operating conditions indicated in the table, it will be observed that the actual pressure drop through the superheater is approximately one-half that in the guarantee. While the temperature drop of the gases through the economizer is 74 deg. higher than actually obtained in the test, the rise in feed-water temperature is 82 deg., as compared to 67 deg. in the guarantee. In the air preheater the temperature drop of the gases is considerably greater than that predicted in the guarantee, as is the rise in the air temperature. It is of interest that the final gas temperature to the stack is only 237.7 deg. and the final temperature of the air leaving the preheater 237 deg.

To provide for coal and ash handling a trestle was built to connect at the same level with the Illinois Central tracks. It is of sufficient length to permit

between 2 and 3.32 c.c. per litre and that the make-up at times was as high as 30 per cent.

It was found impractical to install deäerating heater units for oxygen elimination in the campus proper, so the 8-in. return line to the power plant was made of extra-heavy wrought iron to withstand anticipated corrosion. From this line delivery is made into two 3,000-gal. return tanks located on a platform 50 ft.

above the boiler room floor line. Water flows from these tanks to a 300,000-lb. per hour open cast-iron feed-water heater, equipped with deäerating features for oxygen elimination and with a weir meter for measuring the feed. Centrifugal turbine-driven boiler-feed pumps draw from the heater and discharge through a continuous blowdown system to the economizer.

From the receiving tanks a 12-in. overflow connection is made to a 90,000-gal. concrete reservoir installed in the power house yard. Here there is storage for the excess condensate obtained during the early part of the day, and pure water is available for make-up in case of a shutdown in the main supply from the city.

City water used as make-up is conditioned by a hot-process softener having a capacity of approximately 10,000 gal. per hour. With this combination of hot-process softener, deäerating heater and continuous blowdown equipment, tests have indicated that the oxygen content in the feed water is practically nil, that the water is free from scale-forming matter, and that concentration is kept at a point where heavy overloads may be carried without foaming.

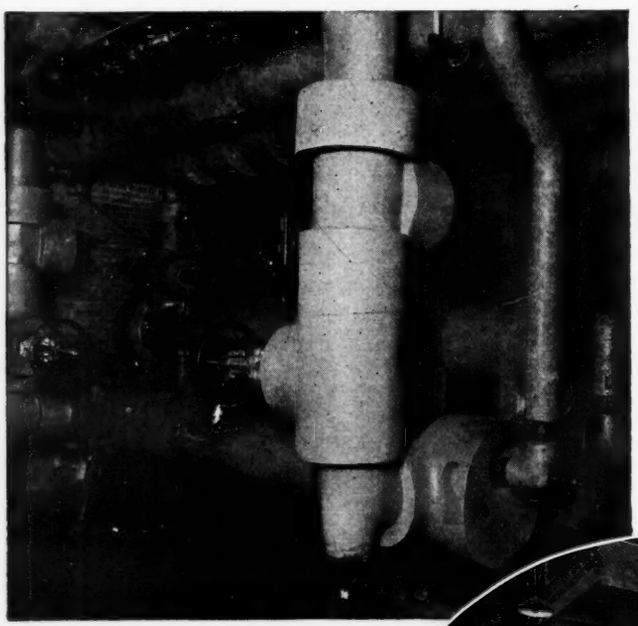
Control of the three 500-gal. per minute turbine-driven centrifugal boiler feed pumps is by excess-pressure governors operated in conjunction with the boiler-feed regulators.

House water is furnished by two automatic self-priming centrifugal pumps. A motor-driven air compressor delivers air at 100 lb. pressure for general service.

A complete air-operated system of combustion control, consisting of a master control, with individual regulation of the independent elements of the system, has been provided. The control extends to the induced- and forced-draft fans, with their complement of dampers, and to the variable-speed drive of the stokers. A full equipment of draft gages and temperature indicators is used in conjunction with the control system. CO_2 is checked with an indicating and recording instrument for each boiler. An indicating, recording and integrating flow meter measures the steam output of each unit. Other meters measure the steam to each of the two 12-in. transmission lines in the tunnel and the steam for station auxiliaries. The feed-water meters are checked by a weir meter in the feed-water heater. Accurate indications of the pressures for all services are shown by the steam gages.

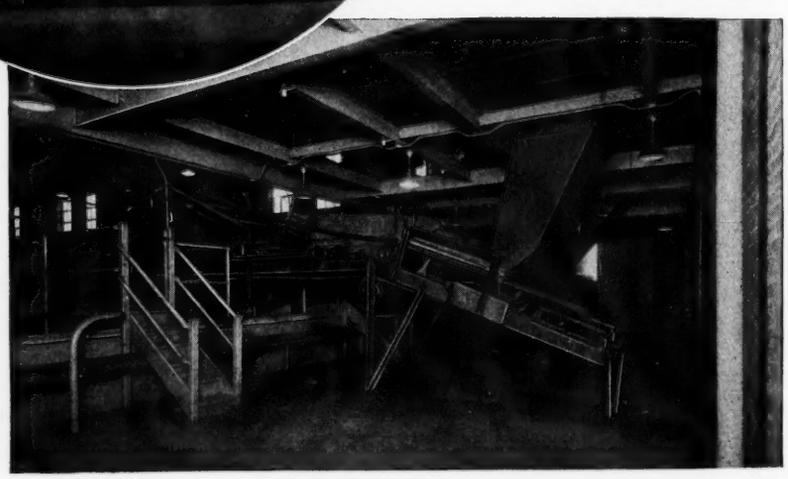
To connect the new plant with the older station and with the existing tunnel system and piping, a new steam transmission tunnel 8 ft. wide x 7 ft. high and approximately 5,000 ft. long was constructed. The elevation of the roof slab varies from 4 to 10 ft. below grade. Expansion pipe areas are provided every 300 ft. in the tunnel. Hanger beams, inserts and piers support the transmission lines. Fresh air intakes at each expansion area, together with access manholes and removable slabs, provide for the addition of future transmission lines.

The maximum steam pressure required within



Continuous blow-down three-unit deconcentrator

Typical air pre-heater and forced-draft fan installation



Pivoted bucket carrier delivering to belt conveyor over coal bunker

TABLE I—ESTIMATED STEAM AND ELECTRICAL LOADS

Season	Bldg. Contents, Cu.Ft.	Boiler Steam, Lb. per Hr.	Max. Demand, Kw.	Yearly Current, Kw.-Hr.
1931-1932	50,817,340	254,100	2,033	6,890,000
35-36	56,032,640	280,200	2,241	7,600,000
40-41	66,492,640	330,000	2,660	9,030,000
44-45	67,992,640	339,900	2,720	9,230,000

the confines of the quadrangle is approximately 100 lb., but to reduce the size of the high-pressure steam line the system was designed for an initial pressure of 150 lb. The two 12-in. lines carrying high-pressure steam are capable of delivering 150,000 lb. per hour, with the initial pressure given and a pressure drop approximating 1.5 lb. per 100 ft. of length. With 150 deg. superheat at the power house, the steam is free from condensation upon entering the quadrangle loop. Two 3-in. high-pressure drip lines with traps at every expansion area drain the high-pressure supply lines. The water is returned to the heater in the power house.

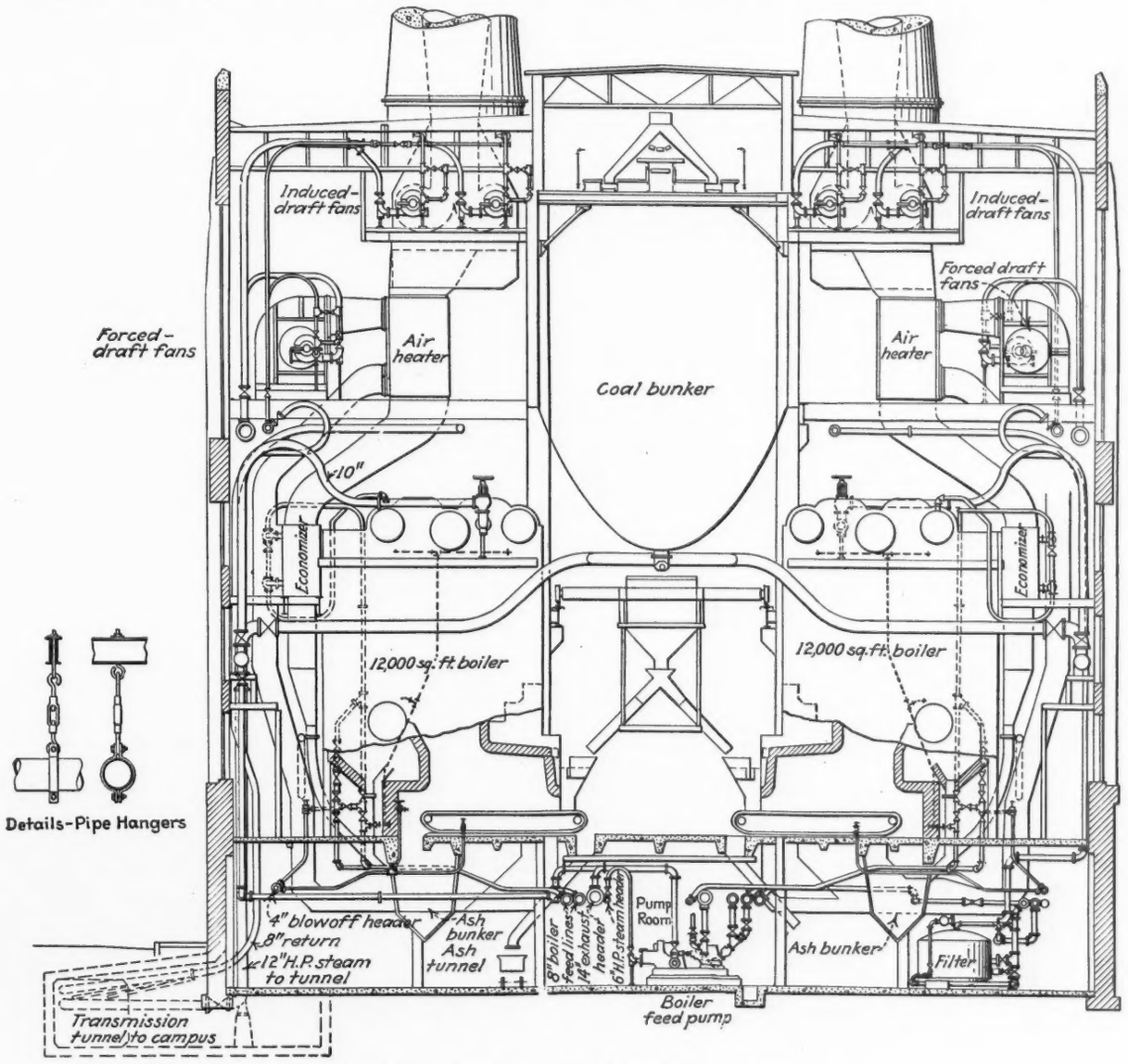
All condensate from the heating and high-pressure steam service is collected at centrally located stations and forced back to the power house by electric pumps through an 8-in. line in the tunnel. This line has capacity to handle approximately 210,000 lb. of condensate per hour, with a drop of 59 ft. per 100 ft. of length.

At the power house entrance of the tunnel a reducing valve controls the pressure in the heating main and at the various areas where the high-pressure-steam transmission line connects with the quadrangle loop distributing system. Pressure-reducing valves permit of proper regulation of the pressure in the branch lines.

With a few exceptions, the various pipe lines are welded. All of the pipes are anchored at a central point between expansion areas, as well as at the center of the loop at each expansion area. The straight runs of piping are swung from hangers supported from an overhead beam. Special tables near the expansion areas support the pipes and permit expansion adjustment. The piping

TABLE II—OPERATING DATA AND GUARANTEED OPERATING CONDITIONS

Steam produced per hour, lb.		76,000
Percentage of boiler rating		210
Average steam pressure, lb. gage		144.8
Final steam temperature, deg. F.		538.5
Superheat, deg. F.		175.5
CO_2, per cent		12.8
Feed-water temperature, deg. F.		210.3
Superheater:	**Observed**	**Guarantee**
Superheat, deg. F.	175.5	156
Pressure drop, lb.	4.5	9.2
Economizer:		
Temp. drop, gases, deg. F.	109	183
Temp. rise, water, deg. F.	82	67
Air preheater:		
Temp. drop, gases, deg. F.	153.3	127
Temp. rise, air, deg. F.	174	159
Final gas temp. to stack, deg. F.		237.7
Final air temp. from preheater, deg. F.		237



Sectional elevation through the boiler house

was cut short and the loops spread when cold, approximately 2 in. for every 150 ft. of pipe. Expansion indicators are welded to the pipe on each line, with a gage set for the position of the pipe when cold.

As a point of interest, the theoretical expansion of the 12-in. high-pressure lines for a run of 1,700 ft. was checked by measurements at these indicators and the results, reduced to 100 ft. length of pipe agreed within 0.03 in. In other words, the theoretical expansion per 100 ft. of length was 3.38 in. and the measured expansion 3.41 in.

Construction costs for the power plant and the tunnel, not including the price of the property or the engineering fee, are given in Table III. The figures for the cost of construction of the concrete tunnel include the removal and replacement of pavement, changing water and gas mains in the Midway, together with the moving and replacing of gas mains, water mains and car tracks. The cost of protecting trees, of surfacing, regrading and seeding also appear in the total.

Neiler Rich & Company, consulting engineers, of Chicago, made the surveys, tests and reports mentioned in the article, and designed and supervised the construction of the new power plant and tunnel and the steam and electrical distribution system. R. L. Flook, superintendent of construction for the University of Chicago, was associated in the design and the construction.

TABLE III—POWER PLANT, TUNNEL AND STEAM-TRANSMISSION COSTS

Power Plant Building	
Complete power house building, including bunkers and boiler foundations; 950,000 cu.ft. at $0.37 per cu.ft.	$353,000
Complete track structure with coal tunnel, including wood trestle connection to Illinois Central right-of-way	66,000
Water storage reservoir, 90,000 gal., concrete	11,000
Steam Transmission	
Reinforced concrete tunnel; 5,000 ft. at $90 per ft.	$450,000
Transmission piping, complete with cross connections, bilge and return pumps, two 12-in. high-pressure mains, one 8-in. condensate line and two 3-in. drip lines; 5,000 ft. at $41 per ft.	205,000
Covering, non-conducting insulating for all steam, water and drip lines, including painting; 5,000 ft. at $13 per ft.	65,000
Wiring for light and power for pump operations; 5,000 ft. at $2 per ft.	10,000
Total cost for transmission line, including concrete tunnel, piping, covering and pumps; 5,000 ft. at $146 per ft.	$730,000
Cost of Mechanical Equipment For Power House	
Boilers, three 12,040 sq.ft., stokers, water walls, brickwork, arches, insulation	$190,000
Superheaters, economizers, air preheaters and stack bases, stack lining, forced-draft fans with turbines, breeching and air ducts	125,000
Coal and ash handling, ash cars and track, stoker hoppers, ash chutes to Peck carrier	48,000
Piping, covering, air ducts, breeching and miscellaneous equipment	166,000
Air compressor, feed-water heater, water-softening plant.	19,000
Boiler-feed pumps, 3, wash-out pump and 2 service pumps.	13,000
Test scales and miscellaneous tanks	6,000
Combustion control and measuring instruments	24,000
Wiring transformer vault, transformers, light and power.	24,000
Two steel stacks	6,500
Total for mechanical plant	$621,500

Principal Equipment in New Boiler Plant of University of Chicago

Boiler Equipment

Boilers, three, 4-drum Heine V-type, 12,040 sq.ft. each, built for 300-lb. working pressure..Combustion Eng. Corp.
Superheaters, convection, 150 deg. at 250 lb. pressure .....Foster-Wheeler Corp.
Water walls, 162 sq.ft. per boiler..Combustion Eng. Corp.
Brick settings .....National Power Constr. Co.
Firebrick .....Chicago Retort & Firebrick Co.
High-temperature cement, "Fraxite"..John-Manville Corp.
Boiler insulation, Sil-O-Cel brick....Johns-Manville Corp.
Arches, concave-convex, suspended.....M. H. Detrick Co.
Soot blowers .....Diamond Power Spec. Corp.
Steam purifiers .....Hagan Corp.
Combustion control .....Hagan Corp.
Feed-water regulators, S-C.....Swartwout Company
Water columns .....Yarnall-Waring Co.
Safety valves .....Crosby Steam Gage & Valve Co.
Blowoff valves .....Yarnall-Waring Co.
Non-return valves .....Edward Valve & Mfg. Co.
General steam and water valves.....Crane Company
Edward Valve & Mfg. Co.
Pressure-reducing valves, pilot-operated..Swartwout Co..
G. M. Davis Regulator Co.
Piping, power house .....Crane Company
Piping in tunnel .....Geo. B. Limbert & Co.
Pipe covering .....Keasbey & Mattison Co.
Steam-fitting contractors .....W. A. Pope
Breechings and flues .....George J. Fee, Inc.
Stacks, two, steel, stream-line, 10 ft. inside diam. at top, 150 ft. high above grade....Prat-Daniel Corp.
Stairways and ornamental iron.....Wetzel Iron Works
Subway grating .....W. F. Klemp Co.
Elevator, automatic push-button.....Otis Elevator Co.

Boiler Auxiliaries

Stokers, three, f.d. chain-grate, 280 sq.ft.; drive, 5-hp. Westinghouse motor through Reeves variable-speed transmission .....Combustion Eng. Corp.
Economizers, three, 3,360 sq.ft. each..Foster-Wheeler Corp.
Air heaters, three, plate-type, 10,080 sq.ft. each, Prat-Daniel Corp.
Induced-draft fans, two per stack, total cap., 343,000 lb. of gas per hour at 314 deg., maintaining 5.35 in. w.g. draft at fan inlet; drive of each fan, 100-hp. G.E. turbine with reduction gearing; speeds 3,600 and 820 r.p.m. .....Prat-Daniel Corp.
Forced-draft fans, three, double-inlet, top hor. discharge, 70,000 c.f.m. against 4½ in. s.p.; geared to 80-hp. G.E. turbine, speeds 3,600 and 1,150 r.p.m...Clarage Fan Co.

Pumps

Boiler feed, three, 4-in., 3-stage, 500 g.p.m. against 280-lb. head; drive, 124-hp. G.E. turbine, 2,200 r.p.m., Worthington Pump & Machy. Corp.
Excess-pressure pump governors..Foster Engineering Co.
Boiler washout pump, one, outside center packed, duplex; 14x8½x15-in. .....Worthington Pump & Machy. Corp.
Service pumps, two, self-priming, 3x5-in., 250 g.p.m., 198-ft. head; drive, 25-hp. Westinghouse motor, 1,720 r.p.m. .....Nash Engineering Co.
Soft-water pumps, two, 2-in., 160 g.p.m., 180-ft. head, water 212 deg.; drive, 7½-hp. Westinghouse motor, 1,750 r.p.m. .....Nash Engineering Co.
Filter-wash-water pumps, one 5-in., 750 g.p.m., 30-ft. head; drive, 10-hp. Westinghouse motor, Dayton-Dowd Co.

Feed Water Equipment

Hot water process system, 10,000 gal. per hr., International Filter Co.
Feed-water heater, 300,000 lb. per hour deaerating, with weir meter attachment .....Cochrane Corp.
Deconcentrator, 3 unit, one high-pressure and two low-pressure .....Henszey Deconcentrator Co.
Weightank scales, feed-water, two..Fairbanks, Morse & Co.
Tanks .....Lasker Iron Works
Air compressor, single-stage, 10x10-in., 249 c.f.m., 100-lb. press.; drive, 40-hp. Westinghouse motor, Bury Compressor Co.
Steam traps .....Boylston Steam Specialty Co.
Illinois Engineering Co.

Coal and Ash Handling

Coal handling; automatic shaking feeder mounted on rails, 36-in. belt conveyor, 225 ft. c. to c.; 48-in. pan conveyor, 40 ft. c. to c.; Peck carrier, 24x30-in., hor. run 55 ft., vertical centers, 98 ft.; 24-in. belt. conveyor, 92 ft. c. to c. .....Link Belt Co.
Traveling weigh larry, 10-ton.....Link Belt Co.
Crusher, ring-type, 200 tons per hr.; drive 100-hp. Westinghouse motor .....American Pulverizer Co.
Bunker, steel, concrete-lined, 1,500 tons, Lakeside Bridge Co.
Industrial ash cars, two, 18 cu.ft. each, roller-bearing .....R. H. Beaumont Co.

Meters

Steam-flow .....Cochrane Corp.
Feed-water .....Cochrane Corp.
CO_2 recorders .....Hays Corporation
Draft gages, 10-point.....Hays Corporation
Pressure gages, ind.....Crosby Steam Gage & Valve Co.
Pressure and temperature recorders, Tycos, Taylor Instrument Co.'s

Old Engines and Generators Rebuilt for Compressors

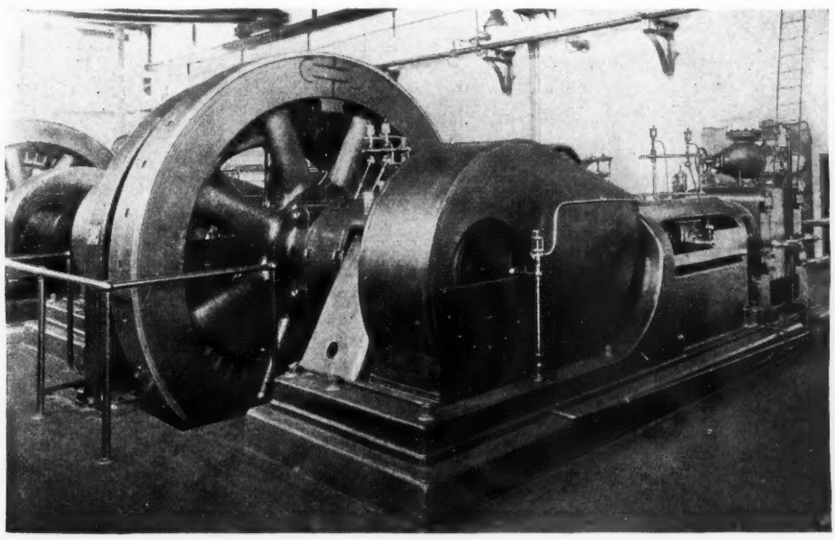
By F. E. Estling
Canadian General Electric Co.
Winnipeg, Canada

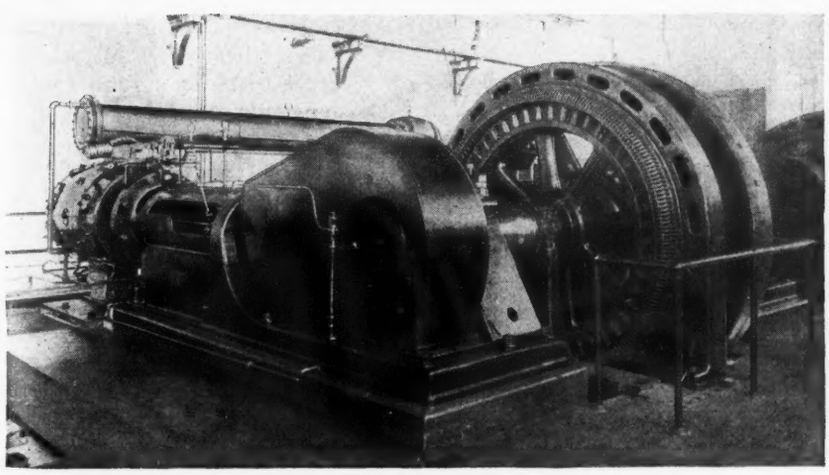
AN INTERESTING DEMONSTRATION of what can be accomplished in utilizing obsolete equipment was recently made by the engineers of the Canadian National Railways in Winnipeg, Canada. In the railway's Transcona shops there were a large number of steam-driven tools, relics of a time when power was developed in a local steam plant. A few years ago, it was decided to purchase power from one of the hydroelectric companies and to discontinue the use of the steam plant.

This changeover left the plant with three 500-kva., 150-r.p.m., 600-volt generators, direct connected to cross-compound steam engines. It was also necessary to provide air compressors for supplying air-driven tools. Several attempts to dispose of the engine equipment proved futile, and inquiries as to prices of compressors showed that their cost would be considerably over the available appropriation. The railway's engineers conceived the idea of converting the steam engines to compressors and the generators to motors for driving them. Ingersoll-Rand engineers were called in and suggested changes to the engines to produce the desired result.

It was then decided to operate the generators as synchronous motors. The addition of amortisseur windings was recommended, together with a reduced-voltage automatic starter for control, the machines being re-rated 550 hp., 150 r.p.m., 600 volts.

The changeover was completed in June of last year. At





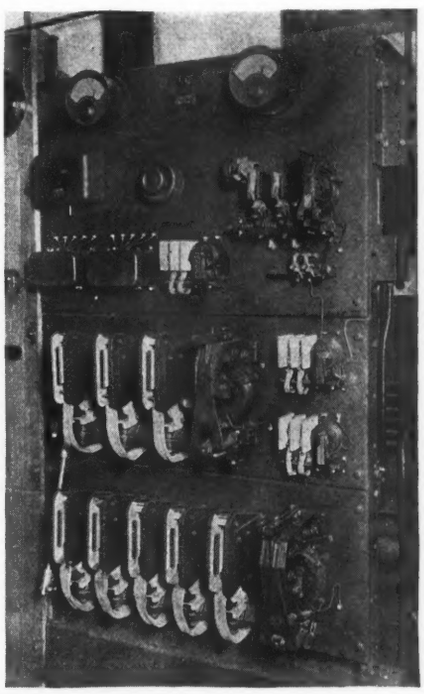


Fig. 1 (Upper Left)—Old steam-engine-driven alternating-current generators

Fig. 2 (Left)—Synchronous-motor-driven air compressors made from engine generators

Fig. 3 (Above) — Automatic starter for one of the motors

the opening ceremony the motors refused to pull into step. To overcome this difficulty the 13-ton flywheel on one of the compressors was removed. The motor then pulled in satisfactorily and ran smoothly at full load. The automatic unloader on the machines operates by opening ports in the ends of the double-acting cylinders. Thus, at three-quarter load the thrust on one side of one piston was removed. But this unbalance caused hunting of the motor, and the load ammeter would swing completely across the meter's scale. At half load balance was more or less restored, but at quarter load the hunting resumed. To get stable operation the flywheel was replaced and attention was turned to the motor's control.

The control was originally arranged to start and pull in the motor with the field winding open circuited. Connections were made to short circuit the field winding through an extra heavy field discharge resistor with the closing of running contactor. This arrangement proved successful and the machine easily pulled into step, the flywheel producing smooth operation at all loads.

The photographs give an idea of the installation. Fig. 1 shows the engines and generators as originally operated, and Fig. 2 one of the air compressor units. Summarizing the results obtained, it was found that the complete cost of the change was slightly less than 50 per cent of the cost of a new machine.

Rebuilding Waterwheel Increases Efficiency

By Hallgrim Thoresen
Consulting Engineer
Oslo, Norway

Changes made in design of a 12,000-hp., 40-ft. head, double-runner horizontal-shaft waterwheel produced a 6.5 per cent increase in efficiency at about 10,500-hp. load

IN THE Feb. 19 and April 8, 1924, numbers of *Power* there appeared a description of the turbines in the Raanaasfoss hydro-electric station and of tests made on them. The relation between the efficiency curves of three of the machines and of the corresponding model runners was not good, even though the guarantees were fulfilled. One reason was the large number of long-surface buckets in the runners. When these were cast into the hub and band they were not set as accurately as in the model runner. Investigation made by the manufacturers, J. M. Voith, Heidenheim, Germany, on similar runners showed, however, that the fault must be due to other causes. The company engineers wished to locate the difficulties and if possible increase the efficiency by redesigning the turbines. An agreement was arranged under which the manufacturers were to rebuild No. 4 unit, and do the research work.

The original model of the runners was re-erected in the research laboratory, and a series of tests was made to find if there was an error in the original results, but the new and old tests were in complete agreement.

A new set of runners was designed with fewer blades and smaller surface than the old ones. Small models were built and tested under a number of heads. These tests showed the output and efficiency to be satisfactory, and a test runner was built of the same dimensions as that made in 1920. It was operated in the guide vanes and casing used in the earlier work. Tests indicated that the efficiency curves of the new runner were considerably better than those for the old. Curve *C* Fig. 3 was obtained from the original unit in 1920 and curve *B* is that for the new runner.

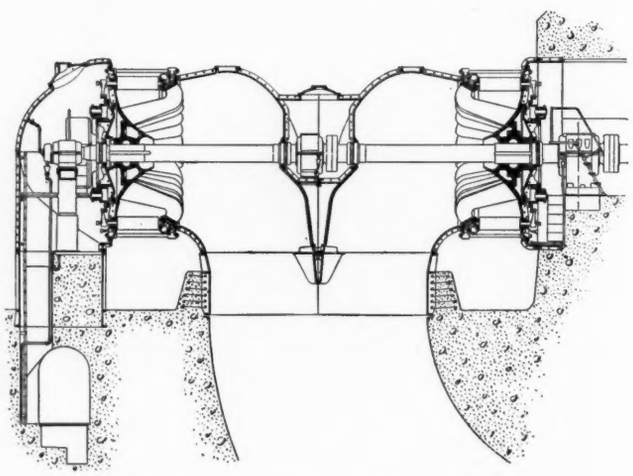


Fig. 2—Redesigned unit with dividing walls removed from the draft tube

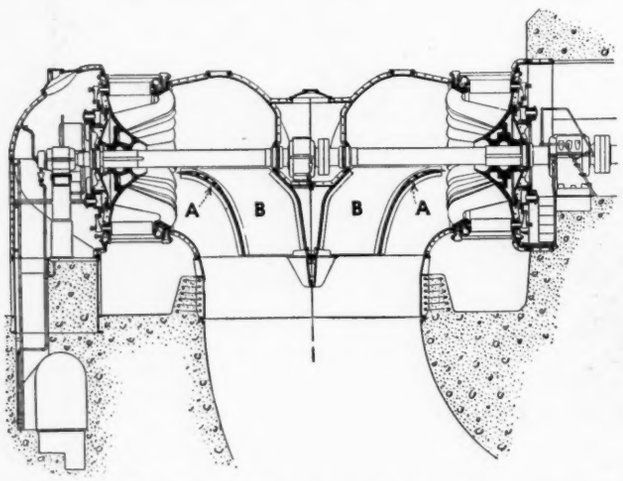


Fig. 1—Original units had dividing walls A and B in the draft tube

New runners were built and erected in the casing of No. 4 unit and tests made to check the relationship between the efficiency curves of the old and the new runners. The new tests were made in the same way as the original ones in 1922. The same number of current meters was used in both (See *Power* April 8, 1924), the only difference being that the new readings were taken by a chronograph. The waterwheel manufacturers had a chronograph built with 12 pens to which the 14 meters were so connected that any 7 could be read simultaneously. This instrument was satisfactory and

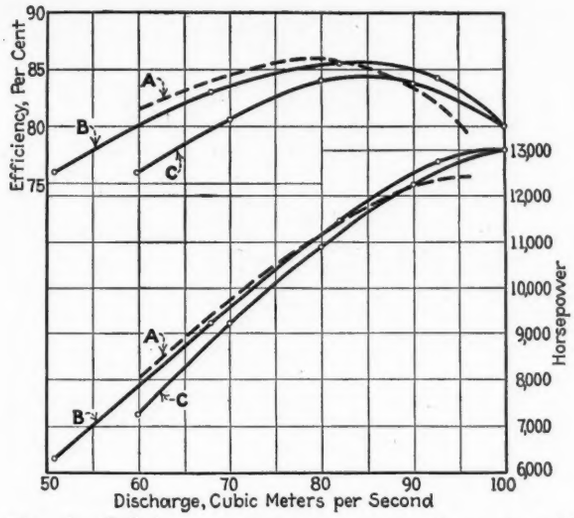


Fig. 3—Efficiency and output curves from the old and the new design

Curves *A* were obtained from the new runners with the dividing walls in the draft tube, curve *B* from a model of the new runners, and curve *C* from a model of the original design.

permitted measurements to be taken quickly and accurately.

The output-efficiency curve shows no increase over that of the model test, curve *A* Fig. 3, and there is a sloping off of the curve similar to that found in 1922. It was decided that the falling off of the efficiency was not due to the runner design but to some other cause.

The Raanaasfoss turbines have double runners mounted in a single housing and discharge into a bent concrete draft tube. The model was tested, however, in a half housing and the water discharged through a straight draft tube. In the draft chambers of the wheels there were dividing walls intended to improve the water flow. During the investigation the question arose as to the effect of these walls on the flow of the water in the draft tube. A double-runner model turbine, an exact duplicate of the Raanaasfoss machine, including the bent draft tube, was built. The dividing walls in the draft tube were constructed so they could be easily removed, and a series of tests made with and without them.

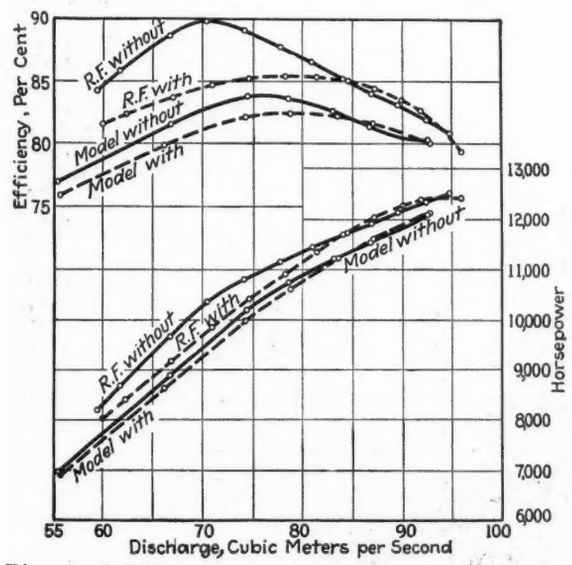


Fig. 4—Efficiency and output curves from the new design with and without the dividing walls in the draft tube

Curves "R. F. With" and "R. F. Without" are from tests made on the unit in the Raanaasfoss plant

Fig. 4 shows the test results worked out for a head of 12.25 meters and a full-sized runner. The curves for the tests made with dividing walls in the draft tube are marked "Model With." The curves marked "Model Without" were obtained without the dividing walls in the draft tube. Outputs obtained without the dividing wall, up to a discharge of 85 cu.m. per second, are above those with the dividing wall. Between 85 and 95 cu.m. per second the output is increased by the dividing wall in the draft tube. The efficiency curves show a similar relation to that between the output curves. Maximum efficiency without the dividing wall is reached at 75 cu.m. per second, at which point it is 1.5 per cent above the corresponding maximum efficiency of the turbine with dividing wall. In the same figure are given the test curves taken at Raanaasfoss. These are identified as "R.F. With" and "R.F. Without." It is interesting how closely the curves for the model and full-sized machine agree. The ratio of the model dimensions to those of the full-size machine was 1:9.2.

As a result of the tests it was decided to remove the dividing wall of turbine No. 4 draft tube. Measurements

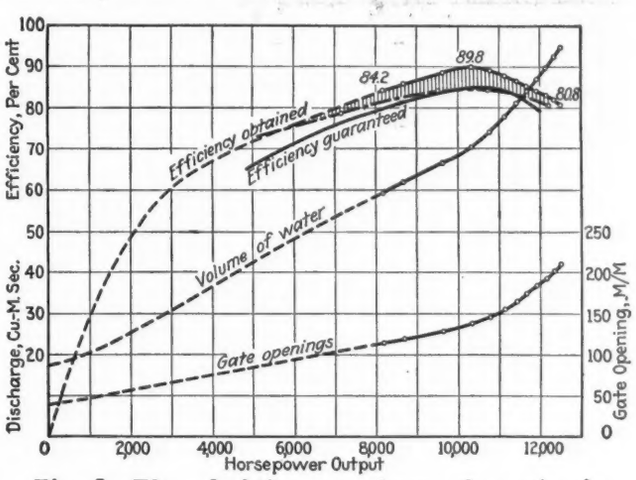


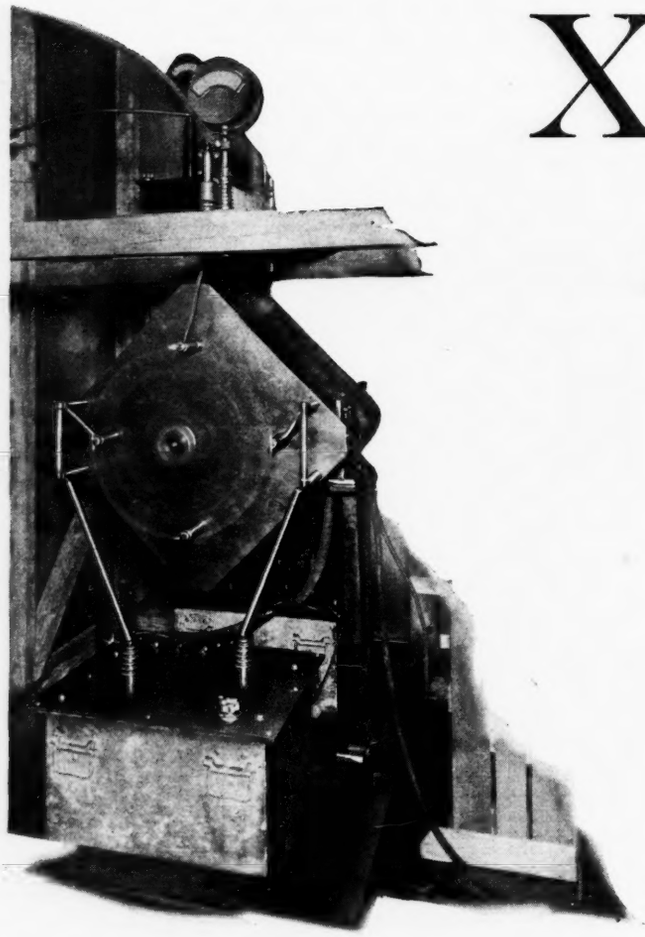
Fig. 5—The shaded area shows the gain in efficiency obtained with the new design

of output with guide-vane openings varying from 100 to 250 mm. were first undertaken. An accurately divided scale was used to read the vane openings, the governor being moved in one direction only, to avoid backlash. As in the original tests, head and output were measured with precision instruments. When the dividing wall had been removed another series of tests was made in the same manner as with the walls in place. From the results of the two series of tests the variation in efficiency due to the dividing wall could be determined, since the water-consumption ratio had already been determined by laboratory tests.

The output and efficiency curves thus found are shown in Fig. 4, marked "R.F. Without." The shape of the curves shows close agreement with the model test results. A maximum efficiency is obtained near three-quarters load, where it is 89.8 per cent.

In Fig. 5 the water quantity and gate opening are shown as a function of the output, reduced to a head of 12.25 mm. In the same figure is indicated the efficiency curve that was obtained in the acceptance tests in 1922. The hatched portion shows the improvement obtained.

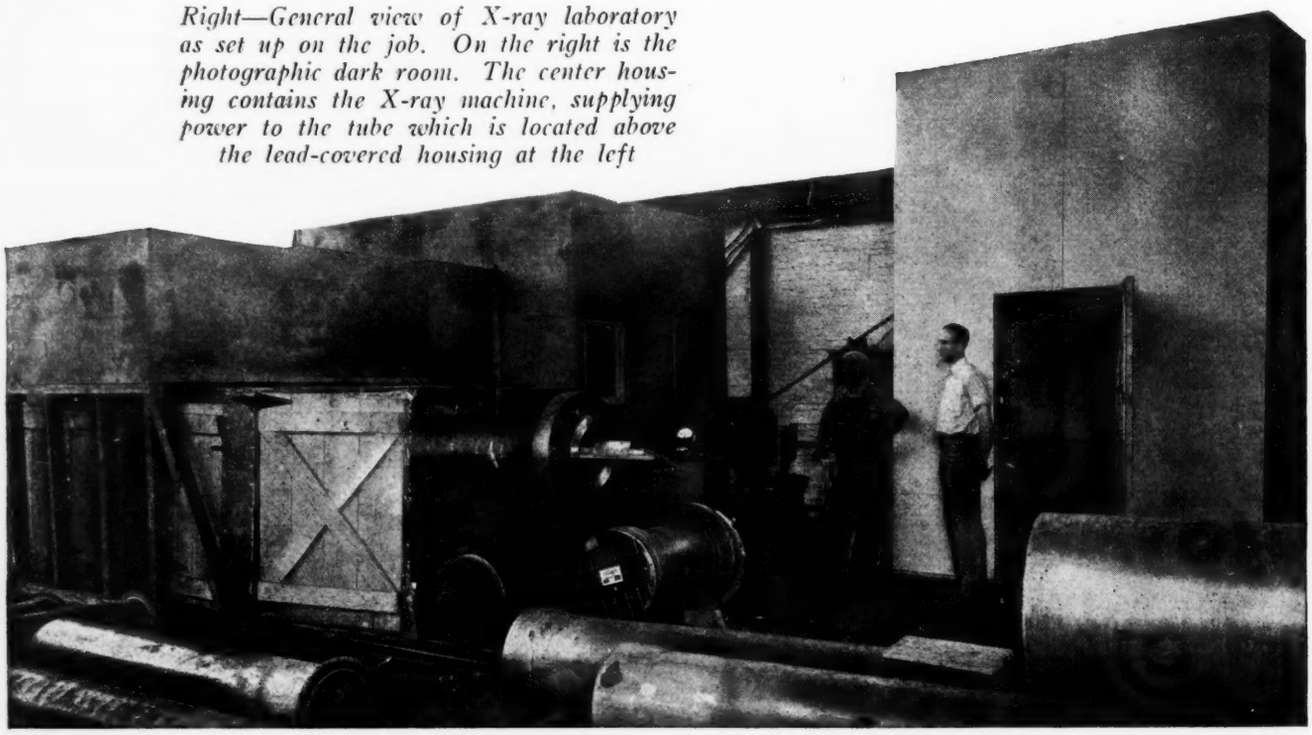
X-RAYING ARTERIES of POWER



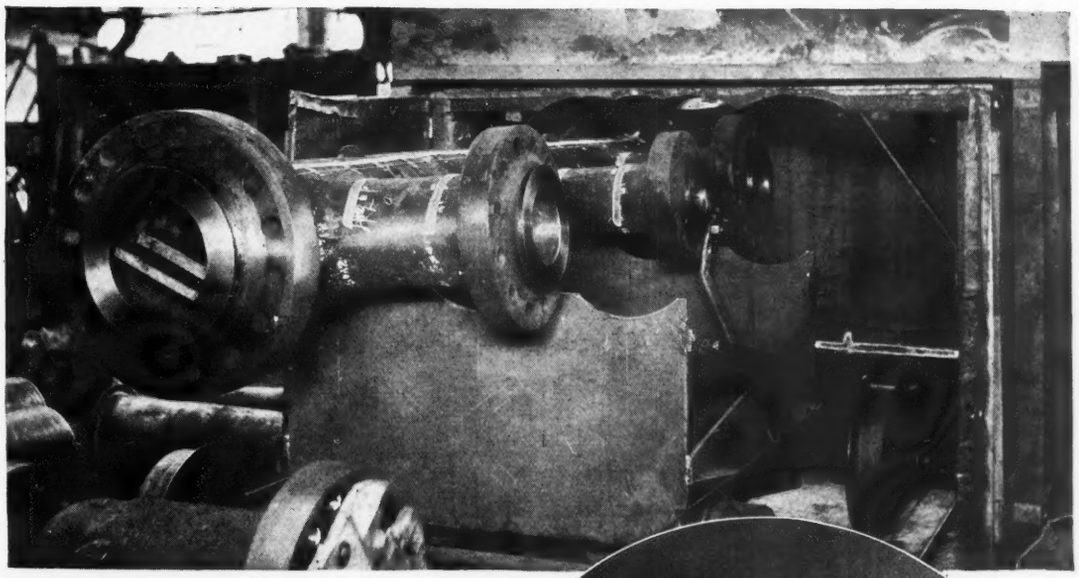
Above—The X-ray expert has his own little power plant, shown above, which supplies direct-current at 200,000 volts

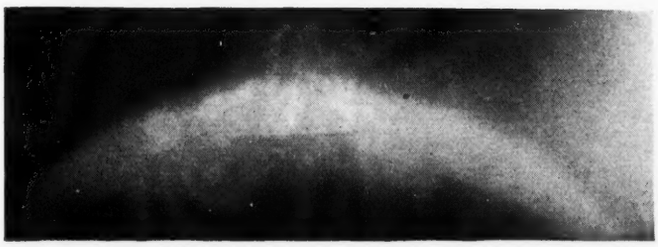
MENTION of the X ray brings to mind its manifold and wonderful applications in medicine and surgery. Few realize that the applications in industry are now growing with startling rapidity. In the power field the American pioneers in high steam pressures a few years back sought the aid of the X-ray specialist to detect flaws in steel castings for valves, fittings and headers. Now, however, we hear for the first time of the heavy X-ray equipment carried to the job. Heretofore the steel castings had always been taken to the X-ray laboratory. By the courtesy of Herbert R. Isenburger, Inc., industrial X-ray specialists, there are reproduced here photographs showing the X ray on the job of inspecting some of the heavy steel castings for a 1,200-lb. steam plant now nearing completion.

Right—General view of X-ray laboratory as set up on the job. On the right is the photographic dark room. The center housing contains the X-ray machine, supplying power to the tube which is located above the lead-covered housing at the left



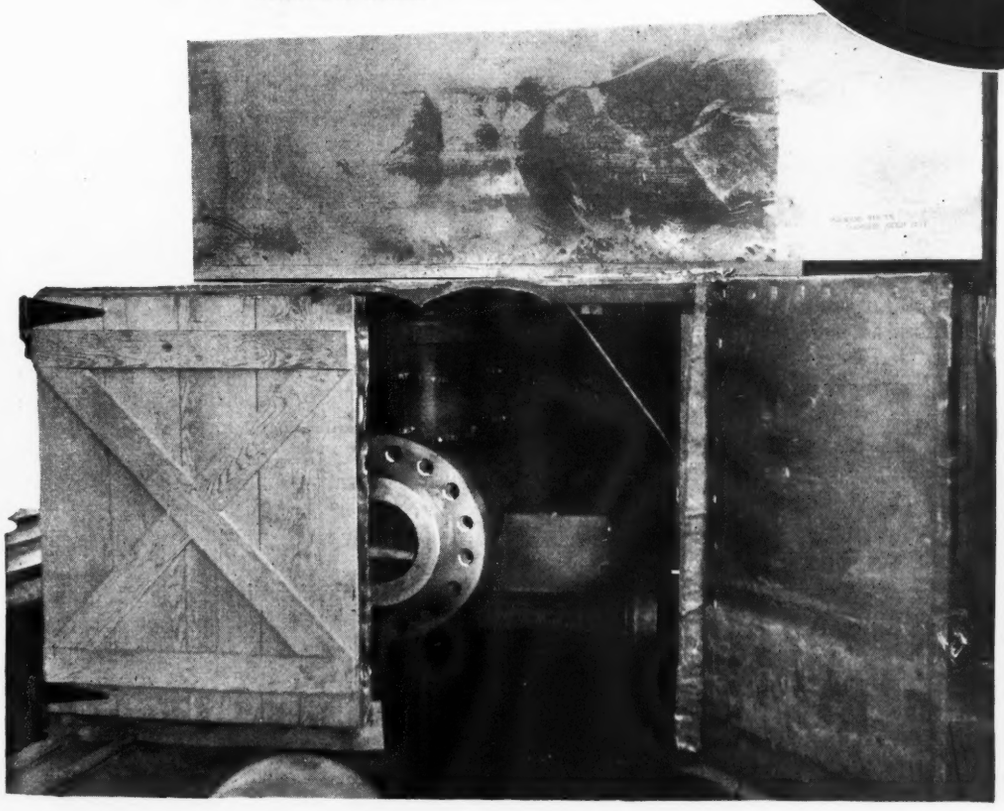
Right—Cast steel header, weighing about 7,000 lb., mounted on truck ready to be moved under the X-ray tube. Adhesive tape strips hold identifying lead markers in place. About 125 pictures will be taken to safeguard this single casting





Typical X-ray photographs showing defects in steel castings

Above—The effect of shrinkage caused by improper riser headers
Right—Sand pocket which was not considered serious



Left — Another view of the header shown at the top of the page. Here it is in place for pictures of the main pipe wall between nozzles. The films, enclosed in "cassettes," are placed on a movable holder within the casting. A heavy lead sheathing protects workers from the dangerous X rays during the long exposures

WHY, HOW AND WHERE TO CORRECT POWER F

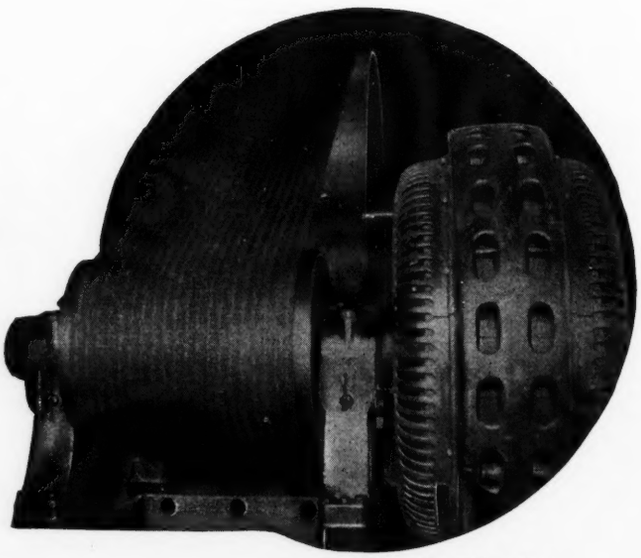
By B. A. Briggs
New York City

ALTERNATING-CURRENT systems in general have a power factor that is less than unity, and it is usually lagging. When the power factor is low power losses in generating and transmission equipment are increased and the system's voltage regulation is impaired. If power is purchased and the rate includes a penalty clause for low power factor, the cost is increased as the power factor decreases below specified values. These and other objectionable effects of low lagging power factors have led to an increasing interest in means for correcting this feature of alternating-current systems.

Certain types of electric furnaces, electric welders, arc lamps, lightly loaded transformers, and other stationary devices have a low lagging power factor. Induction motors, particularly slow-speed types, when partly loaded, have a low lagging power factor. Extensive use of induction motors and a general tendency to overmotor driven machines are the chief causes of low power factor. Therefore, when attempting to correct the power factor of a system, attention should first be given to a better loading of the induction motors. In some plants interchanging motors has resulted in better loading and in a material improvement in the power factor. For example, 5-hp. motors might replace 10-hp. machines, and the 10-hp. units be used on drives that had 15-hp. motors.

It is not possible to obtain a high power factor with induction motors. Even when high-speed types are fully loaded their power factor is only about 90 per cent. Slow-speed motors have a considerably lower power factor even when operating at full load. On machines that have widely fluctuating loads it is not possible to keep the motors loaded, and their power factor will be low. For these and other reasons it is generally necessary to use high-power-factor motors on at least part of the load, or use other means to maintain the system's power factor near unity.

Synchronous motors are used extensively with alternating current. They are usually designed to have unit power factor, with normal field excitation at full load, or for 80 per cent leading power factor. The type of



Mine fan driven by 300-hp. high-speed synchronous motor

motor used will depend upon how much the power factor of the system is to be corrected. If a considerable part of the load is made up of synchronous motors the unity-power-factor type will generally be selected. On the other hand, if only one or two are synchronous motors the 80 per cent leading power factor type will usually be applied.

Synchronous motors are limited to the larger sizes. For slow speed they can be applied in ratings down to about 20 hp. In standard speeds the lower limit of size is about 50 hp. Synchronous-induction motors (Fynn-Weichsel type) are made in the same standard ratings as are general-purpose induction motors. These have characteristics somewhat similar to unity power factor synchronous motors. At full load their power factor is unity and at less than full load it becomes leading. Where all the motors in an installation are small, a combination of part induction and part synchronous-induction may be used to obtain a good power factor. Another solution to the power-factor problem, where all small motors are required, is to use all induction motors and correct the feeder power factor with capacitors (static condensers).

After the motors have been installed the power factor

Why low power factor should be corrected; how to correct it and determine the size of the equipment required; and where to locate this apparatus to be most effective are some of the problems considered in this article

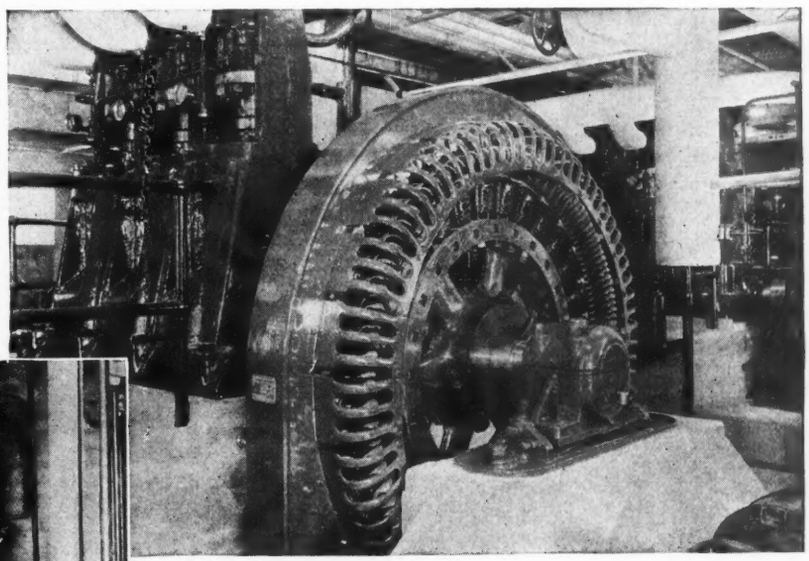
▼

R FACTOR

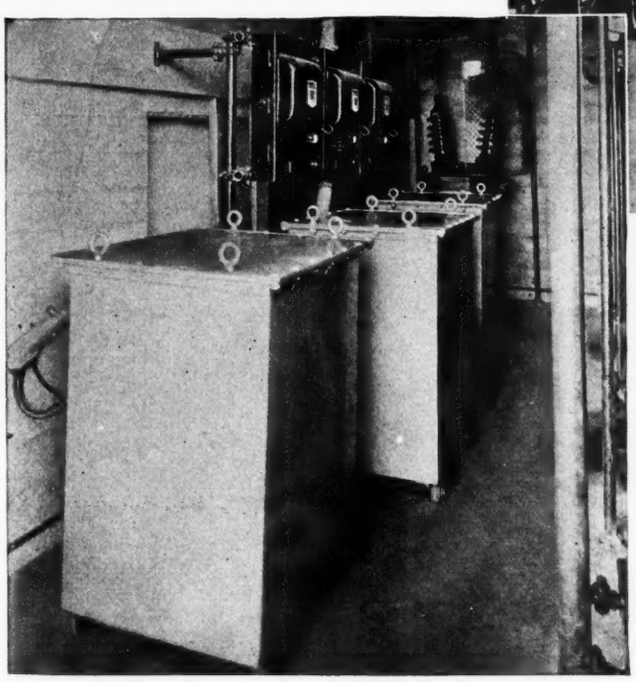
of the feeders can be checked and capacitors installed to give the desired power factor. Synchronous condensers may also be used for power-factor correction, but these are usually limited to large systems. Static condensers can be obtained in almost any capacity, in small and medium sizes. They are compact, have no moving parts and require little attention. These qualities make them well suited to a wide range of power-factor-correction applications where it is not economical to use synchronous motors.

When attempting to correct the power factor of a given load a number of problems are encountered, but these can all be solved by simple diagrams and the use of the accompanying table of power factors corresponding to the out-of-phase angle of the current and voltage. The power factor, which is the cosine of the phase angle, is given to four decimal places to allow a closer interpolation of the fractional parts of the angle. Those not familiar with the mathematics of alternating current need not let that be a handicap, because the method given for solving the problems involves only ability to measure the length of a line and determine an angle with a protractor.

Before power-factor problems can be solved the kilowatt load and the power factor should be known. If



A 300-hp., 4,600-volt synchronous motor drives CO_2 compressor



Three 60-kva., 440-volt, 60-cycle capacitors used as a 180-kva. unit

a wattmeter and a power-factor meter are available the load and power factor can be obtained from their readings. Generally these values will vary so that it will be necessary to arrive at an average condition. If there is no power-factor meter, but wattmeter, voltmeter and ammeter readings can be had, the power factor can be determined by dividing kilowatts by kilovolt-amperes. For example, assume a load of 150 kw., where the voltmeter reading on a three-phase circuit is 440 and each ammeter reads 277. On a balanced three-phase circuit, kilovolt-amperes equals the volts times the amperes of one phase times 1.732 divided by 1,000. In this case $kva. = 440 \times 277 \times 1.732 \div 1{,}000 = 211$. *The power factor* $= kw. \div kva. = 150 \div 211 = 0.71$.

Assume a condition where the kilowatt load is known

to be 150 and the power factor 0.71 and it is desired to correct the power factor to 0.90. What size capacitor is required?

Fig. 1 shows the solution of the problem. Before starting to lay out the diagram, some scale must be assumed. In this case let 1 in. represent 25 kw. Then a line 6 in. long will represent 150 kw. Draw a horizontal line AB 6 in. long to represent the 150-kw. load. A power factor of 0.71 corresponds to an angle of about

POWER FACTORS CORRESPONDING TO THE ANGLE OF LAG OR LEAD BETWEEN THE VOLTAGE AND CURRENT

Angle	Power Factor	Angle	Power Factor	Angle	Power Factor	Angle	Power Factor	Angle	Power Factor
0	1.0000	19	0.9456	37	0.7986	55	0.5736	73	0.2924
1	0.9998	20	0.9396	38	0.7880	56	0.5592	74	0.2756
2	0.9994	21	0.9336	39	0.7771	57	0.5446	75	0.2588
3	0.9986	22	0.9272	40	0.7660	58	0.5299	76	0.2419
4	0.9976	23	0.9205	41	0.7547	59	0.5150	77	0.2250
5	0.9962	24	0.9136	42	0.7431	60	0.5000	78	0.2079
6	0.9945	25	0.9063	43	0.7314	61	0.4848	79	0.1908
7	0.9926	26	0.8988	44	0.7193	62	0.4695	80	0.1737
8	0.9903	27	0.8910	45	0.7071	63	0.4540	81	0.1564
9	0.9877	28	0.8830	46	0.6947	64	0.4348	82	0.1392
10	0.9848	29	0.8746	47	0.6820	65	0.4226	83	0.1219
11	0.9816	30	0.8660	48	0.6691	66	0.4067	84	0.1045
12	0.9782	31	0.8572	49	0.6561	67	0.3907	85	0.0872
13	0.9744	32	0.8481	50	0.6428	68	0.3746	86	0.0698
14	0.9703	33	0.8387	51	0.6293	69	0.3584	87	0.0523
15	0.9659	34	0.8290	52	0.6157	70	0.3420	88	0.0349
16	0.9613	35	0.8192	53	0.6018	71	0.3256	89	0.0174
17	0.9563	36	0.8090	54	0.5878	72	0.3090	90	0.0000
18	0.9511								

45 deg. With A as a center lay off an angle of 45 deg. above line AB and draw a line at this angle with the kilowatt-load line. Then, from B draw a vertical line to intersect the sloping line, thus forming the right-angle triangle ABC. In this triangle the line AB represents the kilowatt load, line AC the kilovolt-ampere load and line BC the reactive component of the load.

If the diagram, Fig. 1, is made accurately the three sides will represent the different loads to scale. If side AB is made 6 in. long to represent a 150-kw. load side AC will be about $8\frac{7}{16}$ in. long, to represent $8\frac{7}{16} \times 25 = 211$-kva. load, and side BC will be 6 in. long, for the $6 \times 25 = 150$-kva. reactive component.

When the power factor is corrected the reactive component is reduced. In this case part of the 150-kva. lagging reactive component is to be replaced by a leading reactive component supplied by a capacitor. As a capacitor load is almost entirely leading reactive, it will directly replace part of the reactive component line BC. To determine the size of the capacitor to correct the power factor to 0.90, find in the table the angle corresponding to 0.90 power factor, which is about 26 deg. Lay off a 26-deg. angle above AB and draw the line AD at this angle with AB. The distance CD, about $3\frac{1}{16}$ in., represents to scale the size of the condenser required, or $3\frac{1}{16} \times 25 = 76.5$ kva.; a 75-kva. unit may be selected. The line AD represents to scale the kilovolt-ampere load on the system after the 75-kva. capacitor is added. On the scale assumed, this line is about $6\frac{11}{16}$ in. long, and therefore represents $6\frac{11}{16} \times 25 = 167$ kva., approximately. Dividing the kilowatt load, 150, by the power factor, 0.90, gives the same results as obtained from the line AD, that is, $150 \div 0.90 = 167$, approximately.

Improving the power factor from 0.71 to 0.90 reduced the kilovolt-ampere load on the system from 211 to 167 kva., or 44 kva. This capacity is now available in generators, transformers and lines to supply additional load when needed. Voltage regulation of the system will be improved and losses reduced. This problem indicates why it is not generally advisable to correct the power factor above 0.90. By installing a 75-kva. capacitor the power factor was raised from 0.71 to about 0.90 or, 19 points. To gain the 10 points from 0.90 to unity would require another 75-kva. capacitor.

Where there is a wide variation in the load, such as between the day and the night periods, the size of capacitor that will give a satisfactory power factor for the day load will be too large for the night load. In such cases the capacitor may be divided into two sections, one section being used at night and two on the day load.

It should be noted that these problems are not worked out to absolute accuracy. This is not required, since the conditions in the power system are constantly varying. The effects of the losses in the capacitors have also been neglected, but are so small they need not be considered.

Where synchronous motors are applied, the effects on the power factor and load are determined somewhat as previously explained for capacitors, except the motor

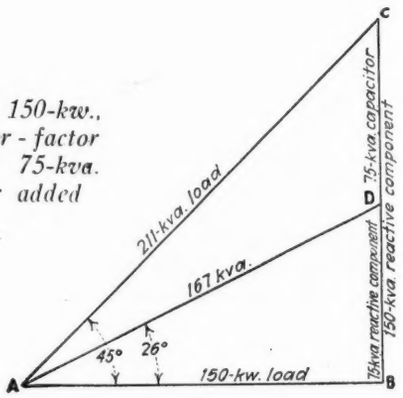


Fig. 1—A 150-kw., 0.71 power-factor load with 75-kva. capacitor added

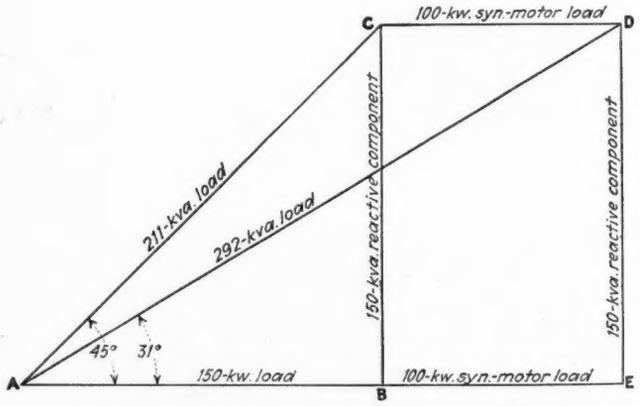


Fig. 2—Same load as Fig. 1, with a 100-kw. synchronous motor added

load must be added in its proper relation to the system load. A load of 211 kva. at 0.71 power factor has a 100-kva. unity-power-factor synchronous motor added to the system, what will the new power factor and load be when the motor is fully loaded?

First, lay out the triangle ABC, to scale, Fig. 2, as in the previous problems. Since the power factor of the synchronous motor at full load is unity, this load represents 100 kw. to be added to the system. Draw a horizontal line on the diagram from C for a distance equal to 100 kw. Since 1 in. is assumed to represent 25 kw., the line CD, which represents the 100-kw. synchronous-motor load, will be 4 in. long. Draw the line AD, which will represent to scale the new kva. load. This line will be found to be about $11\frac{11}{16}$ in. long and will represent a load of $11\frac{11}{16} \times 25 = 292$ kva., approximately.

The motor adds 100 kw. to the kilowatt load of the system, as indicated by the line *BE*, making the total kilowatt load equal to 250. Then the new power factor equals 250 ÷ 292 = 0.856. This value corresponds to an angle of about 31 deg. in the table and checks with the angle between lines *AD* and *AE*.

If the synchronous motor were rated at 100 kva. at 0.80 leading power factor it would be added to the load as in Fig. 3. The original load diagram *ABC* is made as in the previous problems. Since the motor is rated

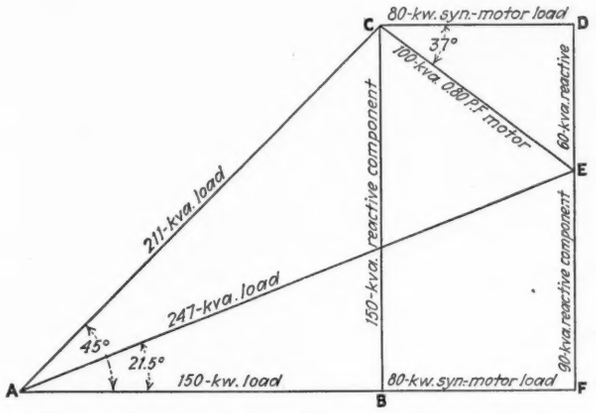


Fig. 3—Same load as Fig. 1, with a 100-kva. 0.80 power factor motor added

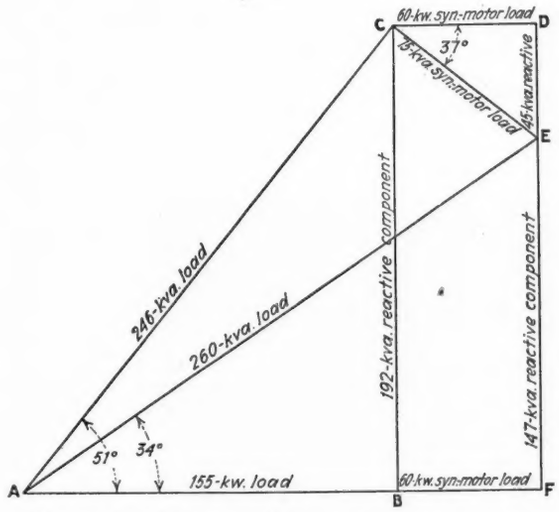


Fig. 4—A 75-kva. 0.80 power-factor motor added to a 246-kva. load

at 100 kva. at 0.80 leading power factor, it represents a 100 × 0.80 = 80-kw. load.

On the diagram draw the motor kilowatt-load line *CD* to scale, which will be 80 ÷ 25 = 3.2 in. long. Referring to the table, it will be found that an 0.80 power factor corresponds to an angle of about 37 deg. With *C* as a center, lay off an angle of 37 deg. below the line *CD* and draw line *CE* to represent 100 kva., the rating of the motor. Line *CE* will be 100 ÷ 25 = 4 in. long. Draw line *DE*. If the diagram has been accurately constructed this line will be vertical. Connect *A* to *E*, which line represents the kilovolt-ampere load on the system after the synchronous motor has been added. The power factor corresponding to the angle between lines *AE* and *AB* will be the new-load power factor.

Using the scale, assume line *AE* will be $9\frac{7}{8}$ in. long. It represents $9\frac{7}{8}$ × 25 = 247-kva. load. The power factor is equal to kilowatts divided by kilovolt-amperes, or 230 ÷ 247 = 0.93. Adding the 100-kva., 0.80 leading power factor synchronous motor to the system increased the load from 211 to 247, or 36 kva. only, and raised the power factor from 0.71 to 0.93.

Another condition frequently met with when correcting power factor occurs where induction motors are replaced by synchronous motors. Take as an example an average load of 215 kw. with a power factor of 0.65. There is a 125-hp. induction motor on the system to be replaced by a synchronous machine.

Find the size of synchronous motor required and what the new power factor will be if an 0.80 leading power factor motor is installed. Disconnect the 125-hp. motor from the line and determine the kilowatt load and power factor without this motor in operation. Assume that without the large induction motor the load drops to 155 kw. and the power factor becomes 0.63. Then the induction motor required 215 — 155 = 60 kw. to drive it. The synchronous motor will require practically the same kilowatt input, which at 0.80 power factor will be 60 ÷ 0.80 = 75 kva. If there is no danger of the load increasing above this value a 75-kva. 0.80 leading power factor

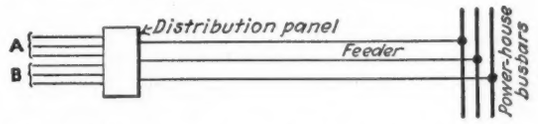


Fig. 5—If correcting equipment is connected on feeders A or B the power factor will be improved back to the power house

motor may be used and the problem worked out on that basis.

First, construct the load triangle as explained in the previous problems. The power factor is 0.63, and as found in the table corresponds to an angle of 51 deg. The load triangle, *ABC* is shown in Fig. 4, which will be assumed to be on a scale of 25 kw. or kva. equal 1 in. To the load diagram is added the 75-kva. synchronous-motor load as shown. How this is done was explained in Fig. 3. Draw line *AE*, which will represent the new kva. load. If the diagram is properly constructed line *AE* will be about $10\frac{3}{8}$ in. long and will represent 25 × $10\frac{3}{8}$ = 260 kva., approximately. The power factor equals (155 + 60) ÷ 260 = 0.83. A power factor of 0.83 in the table corresponds to an angle of about 34 deg., which checks with angle *EAF* in the diagram.

The benefit obtained from power-factor correction depends to a certain degree upon where the corrective equipment is located. The apparatus should be installed out on the feeder system as far as possible. For example, in Fig. 5, if the corrective equipment is connected at the power house busbars the power factor will be corrected in the power house only. By connecting the power-factor-correcting equipment on one of the sub-feeders, such as *A*, the power factor will be improved on the sub-feeder and on the main feeder, as well as in the power house. Correcting the power factor at each motor would be the ideal way; for instance, connecting a capacitor to each induction motor. This method is usually not economical, so correction is generally made by what might be termed the group plan, where a large capacitor, synchronous condenser, or synchronous motor is installed out on the system to correct the power factor for a number of low-power-factor devices.

IMPROVED BOILER PRACTICE

Cuts Fuel Costs

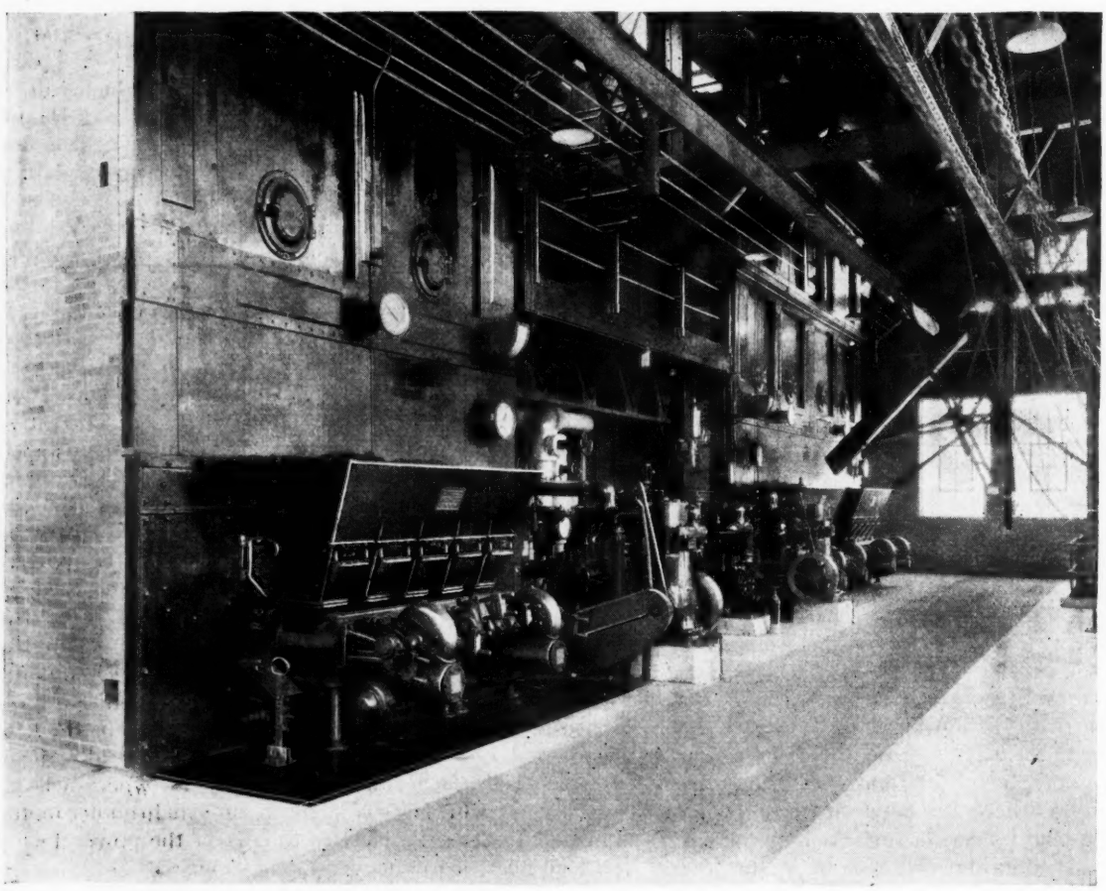
Typical examples of industrial boiler plants where efficient performances were obtained through careful design and modern fuel-burning equipment

THE TREND toward boiler room modernization has been growing steadily as the possibilities of effective, worth-while savings have become evident. Recently I had occasion to check up the results secured in a number of plants through improvement of boiler settings and the installation of modern multiple-retort stokers. On the average, the economies effected were sufficient to repay the cost of the improvements in a surprisingly short time. The results are particularly significant at this time. when the need to cut costs by improving operating methods is so imperative.

A typical example is the boiler installation of a large city hospital, consisting of three 3,890-sq.ft. bent-tube boilers, each fired by a five-retort stoker. Fuel is supplied from a large overhead bunker by a traveling weigh larry that measures the coal to each stoker. Air is supplied by two-speed fans, one driven by a turbine, the other by a slip-ring motor. Automatic regulation of fuel and air is provided.

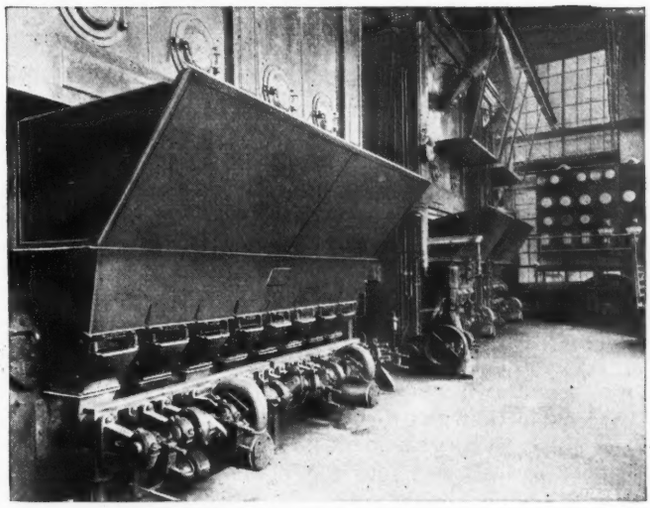
To replace an older plant with smaller boilers and stokers, this modern installation was put in at a time when a new addition was being made to the hospital that increased the steam and hot-water requirements for laundry and general hospital service by 140 per cent, as measured by the average of the steam flow recorder charts before and after the change.

Coal costs average $4.34 per ton delivered. For several years prior to the installation of the new power plant, the hospital office records showed an average yearly consumption of 5,700 tons of coal, at a cost of approximately $25,000. With the modernized plant the average consumption is only 7,600 tons annually at a cost of $33,000. In other words, only one-third more coal is



In this hospital boiler plant only one-third more coal is required to carry a load that has increased 2.4 times

By Robert June

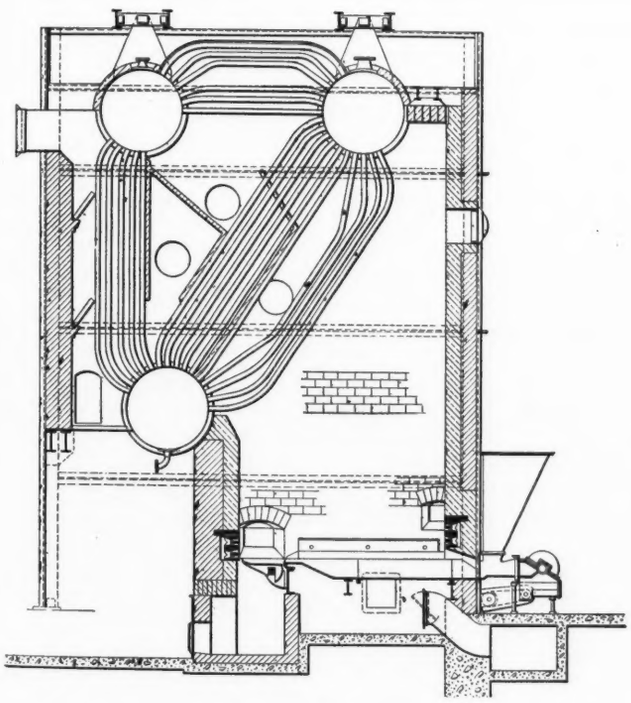


Stoker installation that handles wood refuse and coal "very satisfactorily"

required to carry a load that has increased 2.4 times. Had the hospital continued to burn coal at the old rate, the cost for fuel alone would have been $27,500 more per year.

A modernization program in the boiler room of a well-known automobile plant, in which the settings of the four boilers in use were redesigned and smaller stokers replaced by multiple-retort units, resulted in a big saving in fuel. The drawing, a section through one of the boilers, shows how the setting was arranged for removal of the ash at floor level from the rear of the boiler, no basement, tunnel or substructure of any sort being required.

Steam-flow records show an increase in average evaporation of 1¼ lb. of water per pound of coal since the changes in setting and stoker were made. This is



Setting arranged for ash removal at floor level

equivalent to 12½ per cent saving in fuel. As the plant burns approximately 15,000 tons of coal per year, costing, at $4 per ton delivered, a total of $60,000, a direct fuel saving of 12½ per cent is equivalent to $7,500 a year.

At a Western paper mill the modernization program consisted of redesigning the furnaces and using preheated air in connection with multiple-retort stokers. Illinois screenings containing from 8 to 12 per cent moisture, 30 to 35 per cent volatile matter, 45 to 50 per cent fixed carbon and 10 to 15 per cent ash are burned with marked success. The heat value of the coal averages 10,000 B.t.u. per pound as fired, and the ash fuses at about 1,900 degrees Fahrenheit.

Boilers are of the cross-drum horizontal water-tube type working at 300 lb. pressure and 200 deg. superheat. They are operated almost continuously at 225 per cent rating. The preheater reduces the temperature of the escaping gases to approximately 365 deg. F. Since modernization substantial economies have been reported.

Coal costs were cut 20.2c. per 1,000 lb. of steam by three 4,000-sq.ft. boilers, equipped with 5-retort stokers serving the heating and process requirements of a drug manufacturing plant. The peak winter load is 2½ times the valley summer load. The chart averaging evaporations for twelve months takes the form of an almost perfect "V." Beginning with January, there is a uniform decline month by month until July, after which a steady rise begins and continues until the end of the year. As a result the stokers are forced to carry continuous overloads during the six coldest months of the year. A two-year record shows that steam is produced at a coal cost of 20.2c. per 1,000 pounds.

While not strictly a modernization operation, the results secured by skillful boiler, stoker and furnace engineering at a large automotive-parts manufacturing plant are worthy of consideration. Wide fluctuations in steam demand, owing to the varying requirements of rubber processing, are the rule. There are three boilers equipped with one 8-retort and two 5-retort stokers.

Wood refuse in varying quantities, depending upon the available supply, is burned in combination with West Virginia coal averaging 10 per cent ash and 1.25 per cent sulphur. The wood is fed through a hogging machine, where it is cut to uniform chip size; but as no storage facilities are provided the feed is more or less irregular. Under these unusual and difficult conditions, stoker performance is characterized by the organization's engineering department as "very satisfactory." Furnace maintenance is low. The average load on the boilers is 150 per cent rating, although at times operation at 250 to 300 per cent rating is required and readily maintained. Many plants having burnable refuse could study profitably the results being secured at this plant.

These records of savings due to modernization, and of efficient performance due to careful design and application, are not unusual. Any number of parallel cases can be cited by engineers and manufacturers who have had to do with boiler plant modernization in recent years. The point is, that many opportunities for improvement exist today, and that there was never a greater incentive to undertake such constructive programs.

Modern Designs of Ammonia Coils for Cooling Brine

By Robert A. Wheaton

IN THE DEVELOPMENT of ammonia coils for the cooling of brine it has been determined that the coils are most effective when the brine passes over them with a turbulent action so that as much as possible of the brine comes in contact with the pipe surfaces. In addition, coils should be operated in a flooded condition and the ammonia gas withdrawn as soon as formed.

The old method of construction was to build a series of continuous coils and attach them to headers, as shown in Fig. 1. Liquid ammonia was fed into the bottom header and the ammonia gas was drawn off from the top header. Under these conditions there was only a wet ammonia gas at work on the inside surfaces of the coils, and if too much liquid ammonia was admitted, liquid ammonia would be drawn back to the compressor, with dangerous results. To overcome this the accumulator was perfected. It is placed as shown by the dotted lines in Fig. 2. With an accumulator in the system the coils could be operated when full of liquid ammonia, as any liquid that boiled over from the coils would fall into the accumulator and then flow by gravity back into the system. Further, the accumulator provided a means of precooling the liquid ammonia supply before it was fed into the coils, by running it through a coil in the accumulator, where the suction gas on its way to the compressor would sweep over it. This resulted in drying out the gas and in reducing the temperature of the liquid ammonia going to the coils. This type of flooded system gave much better results than the original direct-expansion system.

However good this arrangement, there was still room for improvement, which led to the development of new types of coils that would permit of the rapid evacuation of the ammonia gas as it was formed. Three typical coils are shown in Figs. 3, 4 and 5, and it is interesting to note their similarity in design to the water-tube boiler.

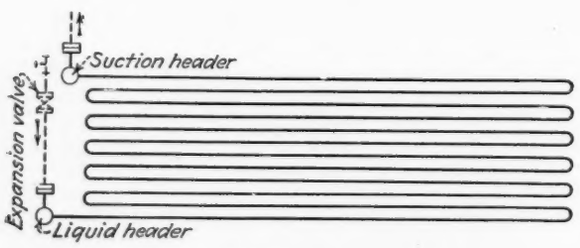


Fig. 1—Simple coil evaporator

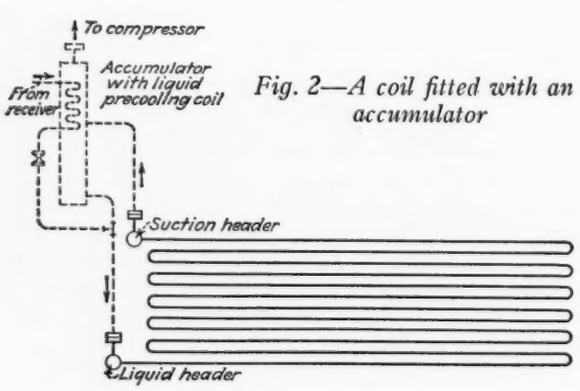


Fig. 2—A coil fitted with an accumulator

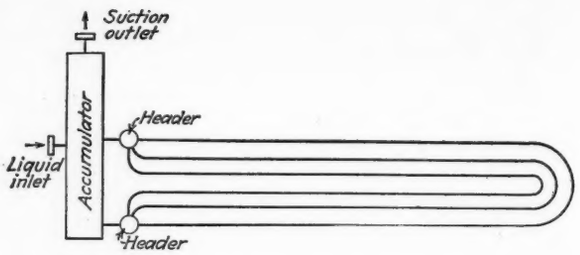


Fig. 3—One of the new designs of coil

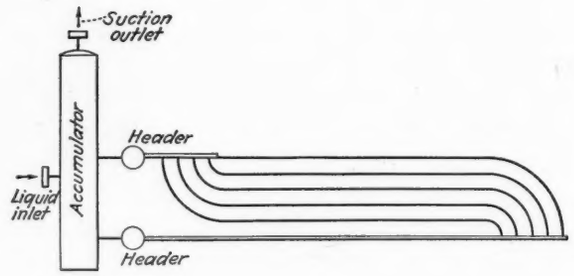


Fig. 4—A coil giving a high heat transfer rate

Attention was directed to new methods of placing them in the brine tank, as it was desired to get a rapid circulation of the brine over the coils. The brine tank was made with a partition and bulkhead so arranged that by means of a propeller the brine could be driven through a compartment in the tank in which the coils were placed.

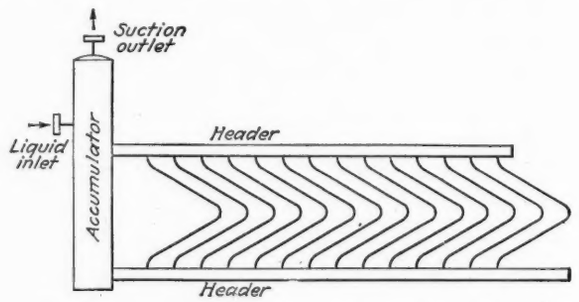


Fig. 5—The herringbone coil used with high brine velocities

The brine swirls and eddies over and around and through the coils, making a very rapid and thorough contact, greatly increasing the heat transfer. With better heat transfers less coil surface is necessary, which naturally reduces the cost of the equipment. The coil shown in Fig. 4 is sometimes made with three sets of pipes between the upper and lower headers, and the compartment in which the coil is placed is provided with a cover. The accumulator is sometimes placed in the tank with the coils.

A float valve can be placed in the liquid receiver to regulate the amount of liquid ammonia fed to the coils. In some plants it has also been found to be good practice to lead direct-expansion suction lines from cold-storage rooms to the accumulator, so that any liquid ammonia from the rooms will be dropped in the accumulator, and thus simplify operation.

Right Out of the Plant

Protecting Fan Shafts From Corrosion

FANS that have to handle hot and corrosive gases often give trouble at the bearings. This is partly due to corrosion and partly to lubrication difficulties.

Chromium plating that part of the shaft in actual contact with the bearing will insure against seizures and burnouts. It gives a hard surface that is not easily scored or worn off. Chromium runs well on white metal, being much less dependent on lubrication than a steel shaft. It also makes the bearing surface resistant to corrosion and pitting by acids.

This method has been used to protect both fan and pump shafts in the oil-refining industry. In one case, after two years' service the plated surface on a shaft has been found intact, with no signs of scoring. The bearings run much cooler and give no trouble from forced stops.

W. E. WARNER.

Brighton, England.

Simple Hoist Used to Handle Transformer Parts

A SIMPLE but adequate hoist for economically handling bushings and radiators during transformer assembly is shown in place on a 15,000-kva. self-cooled transformer, Fig. 1. The vertical member, Fig. 2, is an 11-ft. length of 4-in. extra heavy pipe mounted in a socket consisting of a short length of 5-in. extra-heavy pipe welded to a $\frac{5}{8}$-in. heel plate. At an elevation of 7 ft. 6 in. above the transformer cover a 6-in. 12.5-lb. I-beam 7 ft. long is slung in a horizontal position. The I-beam is connected to the upright member by a collar made up of structural pieces welded and bolted together. A chain block traveler and a one-ton chain block are installed on the I-beam.

The hoist is secured to a timber base which is mounted on and bolted to the transformer cover, through the cover bolt holes. The base mounting is arranged to clear manhole and bushing covers.

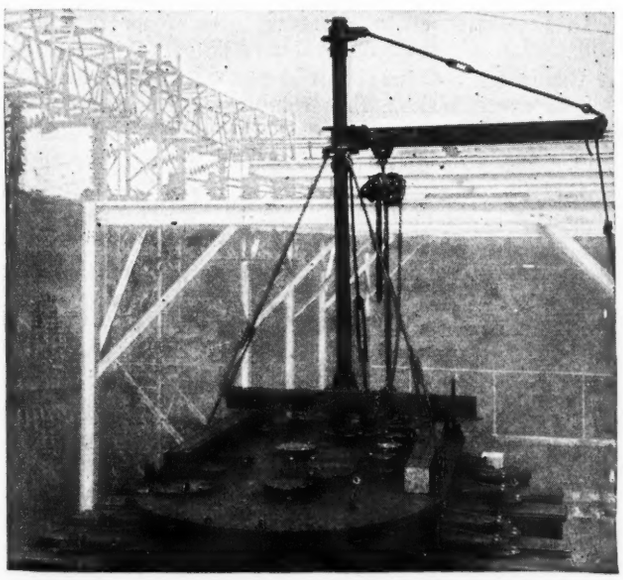


Fig. 1—Hoist in place on top of large transformer

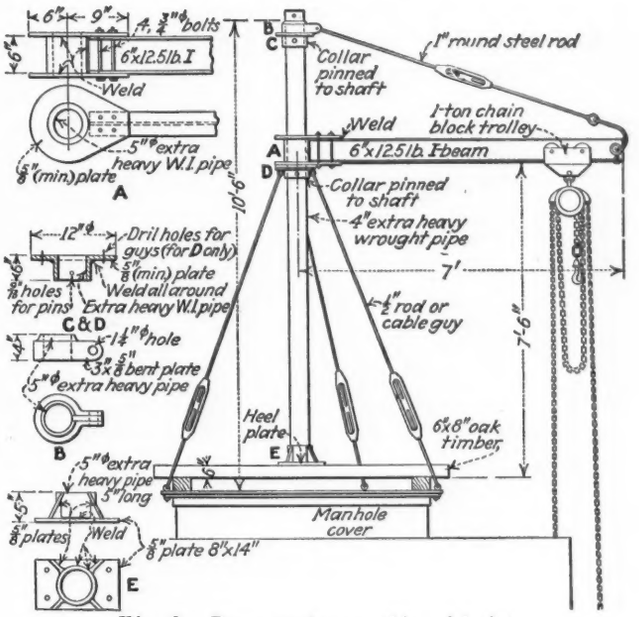


Fig. 2—Parts and assembly of hoist

This arrangement permits ready handling and bolting up of transformer radiators, and is also used for transferring conservator and bushings from points clear of the radiators to the cover. When placing radiators, the weight of each is carried on the chain hoist until the cork gaskets are in place and all bolts are tightened. Two set-ups of this hoist are required for assembly of the complete transformer, approximately one-half of the radiators and bushings being handled at each location.

By increasing the height of the vertical member and by lengthening the horizontal member a hoist can be made which is capable of handling the entire assembly with one set-up.

The hoist was designed jointly by construction engineers of the General Electric Company's Philadelphia district office, and the Pennsylvania Water & Power Company. It has been successfully used with reduction of labor costs and installation time by both companies. Ease of assembly renders it particularly adaptable for movement from station to station.

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Molds for Hydraulic Leathers

IN THE Nov. 5, 1929, number of *Power* E. J. Jordon, in replying to the criticism of W. F. Schaphorst on his previous article, invites information regarding "Making Better Hydraulic Leathers." I was much interested in Mr. Jordon's original article in the June 11, 1929, number on making molds for hydraulic leathers, and I should like to add a few comments.

As regards the making of the molds, cutting, chamfer-

ing and packing with flattening rings, etc., the methods described by Mr. Jordon are in line with good practice, but instead of using belting I would recommend the best calf and buffalo hides, tanned in oak bark. Belt leathers are made suitable for working in tension, and in process are subjected to rolling under high compression. They are also made impervious to moisture. While the hydraulic leather has to work under compression and friction, it must have properties to absorb lubricants and reduce friction to a minimum.

I always use calf $\frac{1}{8}$ in. thick for U-leathers up to 3-in. mean diameter, and buffalo leather $\frac{3}{16}$ in. thick up to 21-in. diameter—both rings working under pressure of $1\frac{1}{2}$ to 2 tons per square inch. The flesh side is made the working surface.

A practical method of making hydraulic leathers is as follows: Cut blanks of necessary size for the biggest diameters, say 24 in. Soak each blank in water of 85 to 90 deg. for one hour. Scrape off all superfluous fleshy parts and apply as much vegetable oil as the blank will absorb. Then make it in a roll and tap it with a wooden mallet, rolling every five minutes along and across the grains, and hammer it until it is pliable. Put it in the mold and press it $\frac{1}{4}$ to $\frac{3}{8}$ in. every ten minutes. If the pressure is applied faster than this the leather will stretch too much and be weakened.

After the press reaches full, allow it to remain for 4 to 6 hr. Take out the cap and allow it to dry in the mold. Cut it and chamfer it, either in the mold or after removing it. After it is finished, dip it in a melted tallow bath for three to four hours, taking care that it is fully dry, otherwise it will open out. A good plan is to wrap it with cotton tape before putting it in the bath. If the ring is to be used at once, apply graphite paste in the inside of the ring only where there is friction.

Other points worth remembering in connection with this work are: Hides treated in lime disintegrate quickly and eat away cast-iron rams. Therefore it is essential to thoroughly rinse the leather after it is allowed to soak. Always soak the blanks and not the whole hide. Use follower rings on the top of the fresh ring and between the gland nut on small pump rams. This prevents cutting of the leathers in the shoulders. The belly portion of hides should not be used for hydraulic leathers. Leathers wrapped in cotton tape can be kept in stock for a long time in good condition.

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Ahmedabad, India. Manekal Harital Mills.

Smoke-Preventing Furnace for Horizontal Return-Tubular Boilers

AN ARTICLE by Russel Melville in the Oct. 1 number of *Power* and one by Gordon D. Rowe in the Nov. 12 number described rather completely the construction of smoke-preventing furnaces.

A little experiment that demonstrates the value of high settings in the elimination of smoke is to take a common candle and light it and hold a cold piece of metal above it. It will be noted that so long as the metal is high above the flame combustion is perfect. However, when the metal is lowered and approaches the flame, it will be seen that combustion ceases to be perfect and smoke is being formed. From this it will be evident that even a fraction of an inch is of a great importance and can be the cause of imperfect combustion and the formation of smoke.

Similar conditions are observed in the furnaces of steam boilers. Instead of the flame of the candle there is a flame of the fuel on the grate, and the cold metal above the candle is the surface of the boiler. Every inch of height above the grate is significant for smokeless combustion. Owing to the fact that it is not always possible or practical to raise the boiler, it is expedient to make an inclined dead plate and lower the grate. In most cases this gives 8 to 10 in. in height from the grate to the surface of the boiler.

Besides increasing the volume of the furnace, the inclined dead plate makes it much easier to see the whole grate and to maintain an even thickness of fuel bed. Inclined dead plates are equally applicable to furnaces of water-tube boilers as to fire-tube boilers. In all cases an increase of efficiency of 2 to 5 per cent is possible.

Harbin, China. M. F. Kocherjinsky.

Water Capacity of Boilers

I HAVE BEEN re-reading the article in *Power* for July 30, 1929, entitled "Steam Storage in Boilers," and am surprised to see repeated the exploded claim that water-tube boilers contain less water in proportion to the heating surface than those of the horizontal-return-tubular type. The opposite is the fact. I used to hear this claim for water-tube boilers and believed it for some years, but finally, to settle the matter, I obtained drawings of three kinds of water-tube boilers and various sizes of horizontal-tubular boilers, and computed the water capacity of each. The horizontal-tubular boiler contained the smaller quantity, and this I have since verified several times.

Engineers in general seem to think only of the tube capacity of water-tube boilers, overlooking the headers and drums, and are willing to believe the statements of the salesmen of those boilers. I have no doubt that the original designers of water-tube boilers expected that the type would contain the least water. If they ever ascertained the facts they must have been disappointed.

It is of little importance whether one type or the other contains the least water, because if the water is once heated to the temperature of the steam, additional heat can only produce steam. The additional heat required to heat the boiler the first time will be small, as the difference in weight of water is small.

In regard to steam storage, there never has been a boiler that held sufficient water to be of any consequence in furnishing reserve steam in case of a drop in pressure.

The common idea that return-tubular boilers cannot be forced is erroneous. I know of an 84-in. boiler with 3-in. tubes $\frac{3}{4}$ in. apart 20 ft. long that is producing over 24,000 lb. of steam according to a steam-flow meter. If there had been no meter it would not have been known. It has 3,520 sq.ft. of heating surface on the fire side, and is, therefore, operating at approximately 227 per cent of rating.

I know of six 90-in. boilers that are fired by pulverized coal to anything that is needed, but are usually run at 150 per cent. These boilers are in pairs, with no center wall, and have 260 3-in. tubes $\frac{3}{4}$ in. apart 20 ft. long. The heating surface on the fire sides is 4,027 sq.ft. The two boilers produce 24 hr. per day 36,000 lb. of steam an hour. I know of many other boilers of this size that are run day and night at 300 per cent rating and have been for years.

If return-tubular boilers are equipped with a perforated pipe for removing steam the whole length of the

drum, the pipe being placed as near the top as possible, they will always give dry steam with proper treatment. To get capacity there should be as many tubes as practicable, and the water glass should have only 6 in. of exposed length.

As for size, there are quite a number of 120-in. boilers in Cuba, and some of 108 in. A number of the latter are insured for 200 lb. working pressure. A 120-in. boiler can be designed with 558 3-in. tubes, and if they are 22 ft. long the heating surface will be around 9,330 sq.ft. They can be operated to produce 60,000 lb. of steam an hour.

On the other hand, I am well aware of the limitations of horizontal-tubular boilers. They cannot be made very large—at least, in comparison with water-tube boilers—nor can they carry very high pressure. A 120-in. boiler can safely be made with $1\frac{1}{8}$-in. plates, and can carry 190 lb. pressure if a saw-tooth longitudinal joint of 92 per cent efficiency is used. With nickel steel a higher pressure may be carried. Two boilers placed in one setting as near together as practicable, and without a middle brick wall, will result in a large boiler whose width overall is about that of a water-tube boiler of the same size.

Concerning what we call thick plates, the law of the resistance to the passage of heat through plates is such that it is only slightly affected by thickness. The important thing is to keep the plates clean on the inside of the boiler. If this is done, there will be no trouble with horizontal-return-tubular boilers. F. W. DEAN.

Boston, Mass.

Straightening Out and Removing Dents From Copper Pipes

ALTHOUGH copper piping is extensively used in the power plant, little thought is given to its physical properties and maintenance until it becomes defective. To straighten out and remove dents in copper pipes of comparatively small diameters, obtain a number of steel balls, highly polished and equal in diameter to the inner diameter of the tubing. Anneal the copper in the dented portion by heating it to a dull red and either allow it to cool down gradually or plunge it into cold water. Drive the steel balls through the entire length of the pipe. A little powdered graphite sprinkled among the balls in the pipe will facilitate the work. Obviously, if the balls can be made to pass through the pipe or tube, the latter will be restored to its original shape.

Dents on copper pipes which will permit a suitable iron or steel tool to enter can be straightened out by hammering or malletting, the projecting dents inside the pipe being forced back by placing the pipe on the tool and manipulating the hammer or mallet so that while the dent rests on the tool the blows will be delivered on each side of it, or around it.

In cases where copper pipes are bulged on the outside, obtain an iron or steel plug and place it in the pipe to serve as an anvil while hammering or malletting the bulge back to the original shape. Anneal the damaged portion of the copper pipe as previously described.

Although a badly ruptured copper pipe can be repaired with a specially made copper welding rod containing a suitable deoxidizer, various tests have shown that modern high-strength bronze welding rod not only produce sound welds, but also produce a weld metal that is tough and of good wear-resisting properties. E. ANDREWS.

Manchester, Eng.

"Finding the Lost Half Inch of Vacuum"

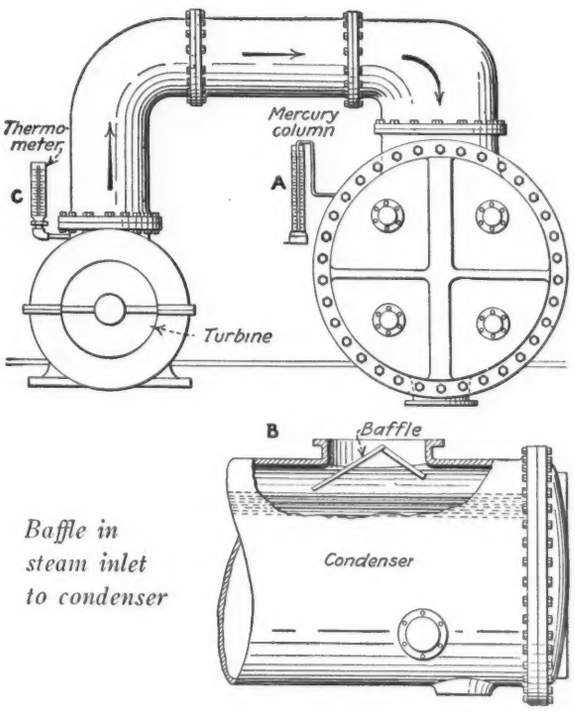
SOME time ago I was called in to correct a low vacuum condition on a steamer equipped with turbines. The steamer was originally built for the government, but together with several others had been sold to a private firm.

The vessels were identical and they all operated without trouble on a fairly high vacuum except the one referred to.

The turbine expert had overhauled the turbine and gears, and found everything perfect; but with the same steam pressure and number of nozzles open the speed of the propellor shaft was consistently two revolutions per minute lower than the other steamers.

A mercury column was located on the condenser at *A*, which indicated 28.5 in. of vacuum. The thermometer *C* on the exhaust connection of the turbine indicated 100 deg. F., which corresponded approximately with 28 in. vacuum.

The drawings of the condensers and exhaust line from the turbine were carefully checked, and found to be the same as the other vessels. The pressure drop, however, was unusual.



Baffle in steam inlet to condenser

Finally, the exhaust connection was removed, and upon examination of the steam inlet to the condenser it was found that a deflecting baffle had been inserted in the condenser as shown at *B*.

The free area for the inlet of the exhaust steam was so restricted that it caused the condition mentioned. After removal of the baffle the operation of the turbine was perfect, the temperature of the exhaust decreased to 91 deg., corresponding to the vacuum in the condenser, and the revolutions of the propellor shaft increased to normal.

The strange part about it was, the baffle had not been shown or indicated on the original drawings of the condenser.

Brooklyn, N. Y. JOHN DOBSON.

FROM AMONG READERS' PROBLEMS

Conducted by
L. H. MORRISON

INTERCOOLING AND AFTER-HEATING OF AIR—*Why is air often heated before being used, when during compression the cylinder jackets are water cooled and an intercooler is used?* J. C.

By removing, during compression, part or all of the heat equivalent of the work done in compressing the air, the power needed to carry on the compression is reduced. Let it be assumed that 1,000 heat units are so removed, reducing the work of compression by 1,000 heat units. Now the engine or power-generating equipment supplying the compressor probably has an over-all efficiency from coal to the compressor cylinder of less than 10 per cent. Then the 1,000 B.t.u. of work avoided by the jacket cooling saves $10 \times 1{,}000 = 10{,}000$ heat units of coal.

Suppose it is desired to restore the 1,000 heat units by reheating the air after it leaves the receiver. The heater should have an efficiency of at least 50 per cent, so we would need 2,000 heat units in coal to reheat the air. The saving is then $10{,}000 - 2{,}000 = 8{,}000$ heat units. The advantage is obvious.

HEAT VALUE OF OIL—*Is there a way to determine the heat value of fuel oil without an expensive test?* J. C.

Sherman and Kropff have discovered that a close approximation of the heating value may be obtained in terms of B.t.u. per pound by adding to 18,650 a sum equal to 40 times the difference between the degrees Baumé of the oil and 10. As an example, suppose the oil is 22 deg. Baumé, then $18{,}650 + 40 (22 - 10) = 19{,}130$, the B.t.u. value of the oil.

EQUAL CUTOFF WITH A *D* SLIDE VALVE—*How can I obtain equal cutoff and equal lead with a D slide-valve engine?* M. H. H.

In setting ordinary slide valves one has to choose between these two conditions, either equal cutoff and unequal leads or equal leads and unequal cutoffs. Usually the leads are made equal, causing the crank-end cutoff to be earlier than the head-end cutoff.

Study of a valve diagram will show that to obtain equal amounts of compression the crank-end exhaust lap should be larger than that of the head-end, in order to cover the exhaust valve earlier, required by reason of the angularity of the connecting rod.

The way the various events are affected by changes in the valve, etc., is shown in the table.

	Increasing Steam Lap	Increasing Exhaust Lap	Increasing Travel	Increasing Angle of Advance
Admission	Later	Not changed	Earlier	Earlier
Cutoff	Earlier	Not changed	Later	Earlier
Release	Unchanged	Later	Earlier	Earlier
Compression	Unchanged	Earlier	Later	Earlier

LOW PRESSURE FOR HEATING—*We have one 1,500-sq.ft. return-tubular boiler, which we operate 24 hr. per day for process heating only during the warmer months, and for both process and factory heating during the winter. The factory is heated by reducing the high-pressure steam from the boiler. Process heating is done by high-pressure steam leading into the water of the open tanks. Process steam is also used for two cranes, which require about one horsepower.*

It has been suggested that the process steam used for open tanks could be low-pressure, and that since we buy electricity it would pay to drive the cranes by electric power.

Would changing to low-pressure steam actually reduce the coal consumed as well as the maintenance of the boiler and heating equipment? Furthermore, since our boilers are operated at very high ratings during the cold days, will a change to low pressure increase the heating difficulties? A. M.

The same amount of heat must be supplied for process heating and building heating irrespective of the pressure at which the steam is generated in the boiler. The number of pounds of steam required to supply this amount of heat is very nearly the same, whether it is generated at 110 lb. pressure, or at, say, 25 lb. pressure. However, there is this important difference: the same weight of steam generated at 25 lb. pressure will have about three times the volume of the steam generated at 110 lb. pressure. This difference in volume may seriously affect the performance of the boiler, in that priming or foaming difficulties may result if low-pressure operation is attempted, which would limit the output of the boiler. There is also the question of pipe-line capacity, since undoubtedly the steam lines are designed for 100 lb. pressure to the various factory processes. There will be practically no discernible difference in the fuel consumption whether the steam is generated at the higher or lower pressure.

SPECIFIC HEAT OF FUEL OIL—*How can the specific heat of fuel oil be found?* R. M.

The specific heat, in B.t.u. per pound, is obtainable from the formula

$$S = \frac{1}{\sqrt{d}} (0.388 - 0.00045\ t).$$

When S = specific heat
d = specific gravity at 60 deg. F.
t = temperature, deg. F.

LATENT HEAT OF VAPORIZATION OF OIL—*Has oil a latent heat of vaporization?* R. M.

Yes. For the oil to vaporize heat must be added. The formula $L = \frac{1}{d}(110.9 - 0.09\ t)$ gives the latent heat.

In this formula L is the latent heat per pound, d the specific gravity at 60 deg. F, and t the temperature at which vaporization takes place.

EFFECT OF HUMIDITY IN OXYGEN CONTENT—*I have been told that the reason a gas engine operates less efficiently in humid weather is that the moisture in the air reduces the amount of oxygen in the air change. Is this correct?* S. D.

No. Dalton's law of partial pressures holds true in case of a gas and a vapor, or in case of air and water vapor in this instance. Consequently, with the air at a given temperature and pressure the weight of air per cubic foot is the same whether there is water vapor present or not. But if water vapor is present the pressure indicated by the barometer is the sum of the pressure due to the air and that due to water vapor. In discussing the effect of humidity one must not fail to take into account the atmospheric air pressure and temperature.

AIR USED BY DIESEL PER HORSEPOWER—*What is the amount of air needed per horsepower-hour and per pound of oil by a Diesel engine.* P. R.

The weight of air used by a Diesel engine can be obtained in a roundabout way only, unless complicated air measuring equipment is used.

The horsepower developed by a Diesel, as in case of all engines, can be found by the formula

$$I.hp. = \frac{Plan}{33{,}000}$$

When P = mean indicated pressure, lb. per sq.in.
l = length of stroke in ft.
a = piston area, sq.in.
n = power strokes per min.

The product of the three factors l, a and n can be used to find the cubic feet of the stroke volume if a is converted into square feet.

The volume V swept by the piston per minute $= \left(\frac{lan}{144}\right)$, from which $144\ V = lan$.

Inserting in the formula and taking the horsepower as unity we have

$$I.hp. = 1 = \frac{Plan}{33{,}000} = P\left(\frac{144V}{33{,}000}\right)$$

If P is taken as 90 lb. per square inch, $V = 2.54$ cu.ft. per min. $= 152$ cu.ft. per hour.

If the engine uses 0.36 lb. of oil per indicated horsepower per hour, the volume of air per indicated horsepower is approximately 422 cu.ft. This assumes that the air entering the cylinder is equal to the stroke volume, which assumption is practically correct.

To find the weight of air, one must know the temperature of the air charge. From examination of exhaust temperatures it seems that on a four-stroke-cycle air-injection engine the air charge will have a temperature of 150 deg. F.

For air, the volume, pressure and temperature have the relations expressed by the equation

$PV = 53.2\ MT$, when

M = air weight, in lb.

T = absolute temperature, deg. F. $= (460 + 150)$.

V = volume, cu.ft. $= 422$

P = pressure, per sq.ft. $= 14.7 \times 144$

Using these volume, pressure and temperature values, we have $144 \times 14.7 \times 422 = 53.2 \times 610M$, or $M = 27.5$ lb. of air per lb. of oil.

An actual engine will use less air than this amount by reason of the imperfection of scavenging. A better figure would be 80 per cent of 27.5, or 22 pounds.

CHROMIUM PLATING OF COMPRESSOR RODS—*In a recent article in Power mention was made of chromium plating being applied to the piston rods of large Diesels. Could it be applied to piston rods of ammonia compressors?* B.C.W.

There is no reason why chromium plating should not be suitable for ammonia compressor piston rods. In fact, many are so plated. The price of plating a rod should not exceed $10 to $15, depending upon the size and condition of the rod.

A Question for Our Readers

IN A water-works plant when the delivery head is 160 ft., the suction lift 12 ft. and the required capacity 500 gal. per minute would a centrifugal pump or would a triplex pump work with more efficiently? Electricity costs 3 cents per kilowatt-hour.

J. B. H.

Suitable answers from readers will be paid for and published in the Mar. 4 number.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

WE WISH to install a 300-hp. Diesel and have it burn the same oil as we use under our boilers, namely 18 to 22 deg. Baumé. Which will work out best, an air-injection or a mechanical-injection Diesel? J. R. B.

EITHER TYPE of engine will handle this grade of fuel oil, as long as you can keep it flowing freely. Heating up the oil when cold and passing it through a separator or purifier should give satisfactory results. Although I would term the oil mentioned a poor grade of fuel for any kind of Diesel, nevertheless, lots of engines are burning it and giving service.

I would suggest that the solid-injection Diesel will give the better results—for several reasons. The greatest development during the last few years in oil engine design is found in this class, and the two-cycle solid-injection engine will handle a more viscous fuel oil than will the air-injection four-stroke-cycle type.

The simplicity of the former engine is an important advantage, which is reflected in the over-all economy of operation. While this is to some degree an inherent feature of all Diesel engines, it is particularly true of the two-stroke-cycle type.

In our plant we have three two-stroke-cycle engines and we are more than pleased with the results.

The primary function of the injection system of a Diesel engine is to introduce the oil into the cylinder against the highly compressed air and to prepare the fuel for combustion. This introduction and preparation of the fuel can be accomplished mechanically (solid injection) or by the use of high-pressure air (air injection). From the standpoint of simplicity, solid injection of fuel is much superior to air injection.

H. J. ACHEE,
Const. Supt.,
Hobart Light & Water Co.
Hobart, Ind.

MOST PRESENT-DAY Diesel engines will operate successfully on fuel oil of 18 to 22 deg. Baumé if the oil is run through a filter or a centrifuge and heated before going to the engine fuel pumps.

An air-injection engine will burn the oil with less smoke from the exhaust, due to better atomization of the fuel charge.

The process of combustion is not as closely regulated in the solid-injection engine, but excellent fuel economy compared to the air-injection engine is obtained in units below 400 horsepower.

The air-injection engine is more reliable than the solid-injection Diesel, but for units below 300 hp. that is not such a great factor. Maintenance costs with the air-injection type will be higher than with the solid-injection, due to more complicated valve gear and to the high-pressure air compressor.

With proper equipment for heating and cleaning of the fuel oil, either type of Diesel will prove satisfactory.

Interest on investment in equipment for burning low-grade fuel, with the necessary extra labor and maintenance, makes a better grade of oil more profitable for a unit of 300 horsepower.

WILLIAM W. DINGWALL.
Walthill, Neb.

FUEL AS HEAVY as 18 to 22 Baumé gravity can be used in Diesel engines. The principal objection to such fuel is that it is difficult to handle through the engine pumps, piping and fuel nozzles in cold weather without elaborate provisions for heating to keep it sufficiently fluid. In addition, the heavy oil is usually dirty and requires centrifuging or other treatment to prevent excessive cylinder, piston and ring wear.

My experience with several makes of Diesel engines, both air-injection and mechanical-injection types, has convinced me that for engines as small as 300 hp. fuels above 22 Baumé gravity are much more satisfactory than fuels below that. In the present stage of development of the two systems of fuel injection, the air-injection will be more satisfactory with heavy fuel than the mechanical-injection system.

Duncan, Okla. J. H. BENDER.

WITH THE heavy oil the exhaust may be smoky, and as smoke is unburned fuel, the fuel consumption may be high. The heavy oil may have to be kept warm to get it to flow easily to the engine.

Only an air-injection engine should be used under such conditions, as this type will burn the fuel better than will a solid-injection engine.

Kimball, S. D. A. WILLIAMSON.

The ENGINEER'S

An Inspiring Life

ROBERT HENRY THURSTON. By William Frederick Durand. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City, 1930. 301 pages; illustrated; 6 x 9 in.; cloth. Price, $4.

TO GRADUATES of Cornell and Stevens, Prof. or Dr. Thurston, as he was known, was a very real, much respected and truly loved personality. To most other engineers, perhaps, he is now little more than a name. Dr. Durand's biography of the man who did so much of the pioneering in engineering education will refresh the memories of the former, and will afford the latter a beautifully written story of the life of a great man.

It is particularly appropriate that this life of Dr. Thurston, first president of the American Society of Mechanical Engineers, should appear just as that body is completing plans for the celebration of its 50th anniversary. Dr. Thurston served as president of the society for two and one-half years and contributed something to every volume of its transactions up to the time of his death. His total of books, articles, speeches and letters is simply amazing when one takes into account the many other activities that engaged his time. An appendix containing the titles of his published works occupies more than 40 pages of Dr. Durand's book.

In some of his earliest addresses Dr. Thurston voiced his belief that politics needed the orderly mind of the trained engineer, and that it was his duty to take an active part in civic affairs. How pleased he would have been could be have lived to see the extent to which engineers are now active in politics and statecraft!

Dr. Durand's book, a labor of love, is truly inspirational and well worth the short time it takes to read it. The society is to be congratulated on its latest venture in the biographies of its outstanding members.

KENNETH CONDIT

For Buildings

MECHANICAL EQUIPMENT OF BUILDINGS. Vol. 1, Heating and Ventilation. By L. A. Harding and A. C. Willard. Published by John Wiley & Sons, 440 Fourth Ave., New York City, 1929. Second edition. 963 pages. Flexible leather, 6½ x 9⅛ in. Price $10.

THIS is a revised and enlarged edition of an excellent and well-known text on heating and ventilating. The amount of data given makes it a handbook that engineers and architects cannot well afford to be without.

The first three chapters discuss the fundamentals and physical properties of heat, water, steam, air and combustion. It is unfortunate that in giving equations for finding the heat loss in the flue gas, the authors have neglected to include the heat loss due to moisture from hydrogen, coal and air.

The next two chapters are devoted to steam and hot-water boilers, and chimneys. Boiler performance, testing, and boiler ratings are discussed and useful data on commercial types of boilers are presented.

Heat transmission through building and insulating materials forms the subject of Chapter VI. Ample heat-transfer data are given, as well as examples which indicate in detail how building heat losses should be calculated. In the next chapter methods of estimating seasonal heating requirements for various types of building are given.

Chapter VIII discusses heat transmission from radiators and the various factors that influence radiator capacities. Heat-emission data and radiator dimensions are given for the cast-iron and extended-surface radiators of several manufactures. Methods of testing are also presented.

This is followed by chapters on steam and hot-water heating systems. Not only are the various commercially available heating systems described, but data are given on pipe sizes, pump capacities and dimensions, inlet-valve and trap capacities, and dimensions of fittings.

Ventilation, air conditioning, air washing, humidifying, drying, and automatic temperature and humidity control are thoroughly covered in three chapters. Other chapters discuss warm-air furnaces, electric heating, district heating and the preparation of plans, specifications and estimates.

An Old Stand-By Revised

ELEMENTS OF ENGINEERING THERMODYNAMICS. By James A. Moyer, James P. Calderwood and Andrey A. Potter. Fourth edition, revised. Published by John Wiley & Sons, 440 Fourth Ave., New York City, 1929. 192 pages; 62 diagrams; 11 tables; insert of high-pressure Mollier diagram; cloth, 6 x 9 in. Price, $2.50.

AS one of the established textbooks on thermodynamics, this requires little in the way of notice beyond calling attention to the issuance of the fourth edition. Certain superfluous material has been eliminated. Chapters VIII and IX, dealing with vapor cycles and flow of fluids, have been rewritten. Other minor corrections and changes have been made.

Perhaps the most significant thing about this edition is the insertion of the full-size high-pressure Mollier diagram prepared by engineers of the General Electric Company on the basis of the steam-table research work at Harvard, M.I.T., and the Bureau of Standards.

Adventurous Scientists

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1928. United States Government Printing Office, Washington, D. C., 1929. 763 pages, cloth; illustrated. Price $2.

SOME years ago when Ray Stannard Baker, effectively disguised for the moment as David Grayson, gave the word "Adventures in Contentment" and "Adventures in Friendship" he did more than just add another book to a year's literary avalanche. He opened a window through which the busy city dweller could glimpse for a moment the real satisfactions of life as these are ordinarily seen only by the countryman of contemplative turn. For many he permanently widened the horizon of existence.

Just so does the Smithsonian widen the horizon of the scientific world for most of us by the material contained in the appendix of its annual report. Immersed as one becomes in the daily flood of detail pertaining to any kind of engineering work, it is difficult to keep oriented to the fast-flashing panorama of modern science. Discovery piles on discovery and the fundamentals retained from college days soon become not only inadequate but obsolete. It is no wonder that one of the most frequently expressed wishes of engineers is for time and opportunity to go back to school and refresh their knowledge.

For those who cannot do so, one recourse is to turn to the appendices of these Smithsonian reports made up of papers on scientific advances. In this latest issue the reader will find astronomy, physics, geology, geography, zoology, anthropology and physiology among the many subjects treated. Each contribution is by an authority, names such as Millekan, Jeans, Hrdlicka and Douglas numbering among those represented.

These papers make fascinating reading as well as serving a useful purpose. To delve into telescope construction with Pease or brave the jungles of Ceylon with Wood is an adventure as well as a benefit to one's store of knowledge—not to mention being a relief from the ever-present mystery tale that forms most of today's recreational reading.

BOOKSHELF

The Shorter Working Week

THE FIVE DAY WEEK IN MANUFACTURING INDUSTRIES. A survey published by the National Industrial Conference Board, 247 Park Ave., New York City, 1929. 69 pages, cloth; 6 x 9 in. Price $1.50.

THOUGH the extent of the five-day week work schedule in American industry is as yet comparatively insignificant, it has decidedly passed from the status of a radical experiment to one of demonstrated feasibility under certain conditions. Furthermore, its potential importance as a far-reaching development must not be underrated. In planning for the future needs of industry, business leaders will have to take into consideration the problems it presents. Welcome therefore, at this time when new economic trends are being formulated, is the published report of a factual investigation on the subject recently conducted by the National Industrial Conference Board.

The earliest instance of the use of the shorter working week noted in this study occurred in 1908. Since that time nearly 300 manufacturing industries and trades, involving more than 400,000 workers, have adopted the plan. While this number is admittedly small in comparison with American industry as a whole, it is important to note that a large majority of those who have tried it are well satisfied with the results obtained. Especially in plants having their own power plants has the extra day's shutdown proved of value for repairs and maintenance work. The experience of many plant operators is summed up in the following quotation from the report:

"The saving from the shorter weekly working schedule most frequently mentioned was reported by plants operating their own steam power plants. While no quantitative savings in fuel were given, the statement was repeatedly made that banking the fires on Friday night without the need of bringing them up on Saturday morning had effected an appreciable saving in coal consumption each week. This was particularly marked in the winter months, when heat as well as power was furnished. Almost equal emphasis was given to the advantage of devoting full Saturdays to maintenance and repair work. The value of this uninterrupted period for a general tuning-up of equipment is being felt with increasing force, if one may judge from the reports received.

"While it had been the general practice in many plants to make periodic, usually weekly, inspections and repair of apparatus and plant on Sundays or Saturday afternoons, this work had often necessarily to be performed under difficulties that rendered it next to impossible to make any but the most obviously necessary repairs. But when this maintenance work could be performed without pressure, it was found that adjustments could be made."

That production, the real test of any industrial operating plan, is maintained, and in some instances increased, in changing from the longer work week to the shorter, was fairly well established as a result of this investigation. Attendance and punctuality were generally found to be improved, and employers were satisfied that five-day operation had a pronounced effect in raising the morale of the working force. In conclusion, the report states, "Like most departures from prevailing practice, the five-day week, at least at first, has certain drawbacks. With respect to this issue, however, the disadvantages appear to have been outweighed by the advantages derived. The preponderance of opinion in favor of the five-day week schedule indicates that in most plants reporting it has commended itself to both management and working force."

Heat Losses Analyzed

HEAT LOSS ANALYSIS, THE KEY TO ECONOMIC BOILER OPERATION. By E. A. Uehling. Published by McGraw-Hill Publishing Company, 370 Seventh Ave., New York City. 241 pages. Cloth; 6 x 8 in. Price, $2.50.

THIS book presents a method whereby boiler heat losses may be analyzed when coal analyses are lacking. For this purpose the only data necessary are the flue-gas analysis, the flue-gas temperature, and the percentage of carbon in the ash.

It is shown that coal of the same type has, within practical limits, the same heating value per pound of carbon. Thus the heating value of a one-pound carbon unit of bituminous coal is given as 17,900 B.t.u., semi-bituminous coal, 17,600 B.t.u. and anthracite, 16,300 B.t.u. The hydrogen present in each class of coal is also practically constant per pound of carbon.

Based on this property of natural fuels, the author has developed simple formulas for calculating and analyzing the heat losses. The heating value of the pound-carbon fuel unit being constant, the engineer can determine the daily operating efficiency of the boiler regardless of the analysis of the coal.

After having shown how the heat losses may be calculated, the author outlines a method for interpreting them to improve boiler efficiency and the efficiency of the operating personnel. The book is intended to give practical assistance to the boiler room operating staff and the directing engineer.

Brief Reviews

NATIONAL ELECTRIC LIGHT ASSOCIATION PROCEEDINGS, VOL. 86. Published by the N.E.L.A., 420 Lexington Ave., New York City, 1929; 1,744 pages, illustrated; price, $15 to non-members; $10 to members. Complete reports of all the committees of the association for 1928-29, as presented at the 52d annual convention in Atlantic City, N. J., last June.

DIATOMACEOUS EARTH. By Robert Calvert. Published by the Chemical Catalog Company, 419 Fourth Ave., New York City, 1930; 251 pages, illustrated; price, $5. One of the American Chemical Society Monograph Series, it describes fully the present uses and future possibilities in industry of diatomaceous earth.

MECHANICAL WORLD YEAR BOOK. Published by Emmott & Company, Ltd., 65 King St., Manchester, England. 1930 edition; 348 pages, illustrated; price, 1/6 net. Like former issues, this edition is an excellent compilation of valuable data and tables on power plant subjects. British engineers regard it as the equivalent of a five-foot library.

DIRECTORY OF RESEARCH ON HEAT TRANSMISSION. Published by the Committee on Heat Transmission, National Research Council, 40 West 40th St., New York City, 1929; second edition; 36 pages; free. A directory of individuals and laboratories engaged in heat-transmission research, with brief outlines of the specific work of each.

DAS "I T" DIAGRAM. By P. Rosin and R. Fehling. Published by the V.D.I. Verlag, Berlin, Germany, 1929; 30 pages, illustrated; price, 7.5 reichmarks. Description, written in German, of a chart relating the volumetric heat content of mixed gas (such as flue gas) to temperature. It provides an interesting mathematical shortcut for the solution of combustion problems.

FABRICATION OF WELDED PIPING DESIGNS. Published by the Linde Air Products Company, 30 East 42d St., New York City, 1929; 84 pages, illustrated; free. A practical treatise containing procedure controls for line joints and fittings, template layout for pipe fittings, and tables for estimating costs of actual installations.

POWER SYSTEM OPERATION Discussed at A.I.E.E. Winter Covention

AT THE winter convention of the American Institute of Electrical Engineers, held in New York Jan. 27 to 31, many of the papers presented dealt with operating engineers' problems. Outstanding among these were five papers on protective devices, and a symposium on power-system planning. A number had to do with problems in lightning protection. Two sessions were devoted to electrical machinery; at one problems pertaining to operation were discussed, and at the other design features were considered. Two papers on loading transformers by temperature rise formed an important part of one session. Electric welding occupied another, at which five papers were presented.

Two groups of papers were devoted to protective devices; one on new switching equipment and describing two new types of lightning arresters. At the State Line Station, near Chicago, 22,000-volt metal-clad outdoor switchgear is used. This installation was described by A. M. Rossman. The design is a departure from customary practice in that all live parts are immersed in oil and inclosed in metal housings, with each phase in an independent compartment.

In the discussion of this paper attention was centered on the economic aspects. At State Line several electrical and switching layouts were considered, but the metal-clad outdoor type showed a considerable saving in cost over the others. It possesses the advantage that all oil switching equipment may be kept out of the generating station.

New Oil Circuit Breakers

Two other papers on switching equipment had to do with the development of a new type of oil circuit breaker. One, "Extinction of a Long Alternating-Current Arc," was presented by J. Slepian, and the other, "The Use of Oil in Arc Rupturing," by B. P. Baker and H. M. Wilcox, was presented by B. P. Baker. The contacts of this breaker are equipped with what are known as Deion grids. They make and break under oil, but when an arc is formed during the interruption of a current it is blown into a deionizing chamber, where the arc is interrupted more quickly than is possible under oil alone. A number of field tests have been made on breakers of this type. On tests made on 66,000 volts and interrupting currents of 1,000 to 6,970 amp. the breaker operated 38 times without inspection. The oil in the breaker broke down at 22,000 volts before the tests and at 19,000 after.

"Development of the New Auto-valve Arrester" was the title of a paper by J. Slepian, R. Tanberg and C. E. Krause that described a new lightning arrester operating on the principle of discharge in restricted passages. It is an improvement on the present commercial auto-valve type, and for a given rating about one-half the size of the earlier design. They can be built for both low- and high-voltage circuits and can be mounted on transmission lines in a manner similar to the insulators.

Thyrite, a new material, peculiarly adapted to use in lightning arresters, was described in a paper by K. B. McEachron. This material is now used in three designs of arresters. The station type is made in 11,500-volt sections, each section containing its own gap, so that no series arrester gap units are required. The distribution type is smaller than the station model and has one-fourth the impulse-current-carrying capacity. The third is incorporated directly in the transmission-line suspension insulators and is designed to absorb much of the normal surge energy as well as to protect the insulators from flashovers.

Planning and operating large power systems; effects of steam-turbine governor action on system stability; the control of power flow in different parts of a system or between systems; loading transformers by temperature rise instead of name-plate rating; and new types of circuit breakers and lightning arresters were subjects of interest to power engineers.

At the power-system planning session five papers were contributed. The first one was by G. M. Armbrust and T. G. Le Clair, on "System Connections and Interconnections in the Chicago District." The Chicago 25-cycle system has a generating capacity of 321,000 kw., and two 40,000-kw. frequency changers operate between the 25- and 60-cycle systems. There is 1,357,400-kw. of 60-cycle generating capacity, making a total of 1,678,000 kw. on the two systems.

Accurate control of load division between the stations is important if the most economical operation is to be maintained. The Commonwealth Edison Company uses a system that automatically indicates in the load dispatcher's office the total system load. This is also automatically indicated in each generating station. Thus the station operators know the total load on the system as well as the loads in their plants. Charts showing the proper division of load between stations, for any given system load, indicate to each operator the proportion of load his plant is to carry.

A method of automatic frequency control is used by which the instantaneous frequency can be held to within 1/20 cycle. Any accumulative errors in frequency are also corrected.

Detroit System

S. M. Dean described the Detroit Edison Company's system, which is supplied from four main generating plants having an aggregate capacity of over 1,000,000 kva. An interconnection is made with the Consumers Power Company by 30,000-kva. 132,000-volt line.

The Load dispatcher assigns to three of the four power plants a definite load, as determined by plant economy, and instructs the fourth plant to hold frequency. Each plant load and the total are continuously indicated in the system operator's office to insure prompt action on the part of the load dispatcher and as a check on the compliance with his orders.

Sufficient running reserve to permit dropping the largest machine in any one plant on the system is maintained at all times. Even with one machine down for overhauling the plant must be able to carry its own load if it loses a second machine or loses its ties with the neighboring power area.

In Philadelphia the peak load of the power system in 1929 was 735,000 kva. as given in a paper on the Philadelphia Electric Company's system by Raymond Bailey. Supplied by steam plants, it has a 220,000-volt connection with the 280,000-kva. Conowingo hydro-electric plant.

The governors of all steam turbines are adjusted for approximately the same regulation, about 3 per cent, while the hydro units are set for 5 per cent. Operating experience, as far as frequency regulation is concerned, has been

generally satisfactory. While there has been no evidence of increased power surges, it is felt that the matter of governor performance during system disturbances is worthy of further study.

Control of the load for the entire system is centralized in the load dispatcher's office, where automatically controlled wattmeters record the power generated at each station. The totalized system load is also recorded. The load dispatcher communicates with the operator in each generating station by telephone, instructing him as to the load his station shall carry.

In the discussion of these papers attention was called to the system-development committees or divisions maintained by some of the large companies. All information on the needs of the different operating departments is brought to the system-planning divisions. Members of the planning committee are representatives of the operating construction organizations. At their meetings they consider requests from different departments and work on a co-ordinated plan to meet them.

Reliability of the system was stressed. Although the greatest opportunity for economy is in the power plant, continuity of service is closely associated with the reliability of the transmission and distribution system. Therefore, it is important that both be given equal engineering consideration.

Turbine-Governor Tests

On power systems where the transmission distances are short and the load density high, surging has occurred. The Duquesne Light Company, Pittsburgh, Pa., has experienced such surges on its system. Tests were conducted to determine the influence the steam-turbine governors have in starting or sustaining such a condition. Those tests were made the subject of a paper "Operating Characteristics of Turbine Governors," by T. C. Purcell and A. P. Hayward.

Their conclusions are that the period of governor oscillations and load oscillations on the generators does not have a time phase that would sustain a surge. The natural governor period is fast enough to eliminate the effect of the variation in steam input on the load output. Governors are sensitive enough to hold the turbine from overspeeding and they tend to check the speed of the turbine during a pole slip.

On an electric-power distributing system involving various kinds of networks, each transforming and transmitting unit must carry a reasonable share of the total load. How to accomplish this was told in a paper, "Controlling Power Flow With Phase-Shifting Equipment," by W. J. Lyman. In the case of a single, co-ordinated system the problem of load division has not in general been troublesome and has been solved by judicious selection of parallel circuits, use of reactors and proper system setups. The advent of inter-company connections has brought together systems of varying characteristics and in some cases has made difficult the control of power flow over tie lines in comparison to the systems which they unite. A special type of regulator equipped for tap-changing under load and connected for quadrature action, synchronous condensers, three-phase voltage regulators, and frequency-changer sets with a frame shifters were suggested as possible means of controlling power flow.

Homer W. West in a paper entitled "Tap Changing Under Load for Voltage and Phase-Angle Control" also discussed the subject of regulation of power flow between systems by means of transformers equipped with tap-changing apparatus for adjusting the voltage under load. It was pointed out that the greatest problem in connection with phase-angle control with static transformers is not the equipment, for it is available in simple and reliable form. It lies rather in the calculations of the amount of phase shift required for the varying conditions under which load is delivered.

Operating Transformers

Two papers, one by W. M. Dann, "Operating Transformers by Temperature," and another by V. M. Montsinger, "Loading Transformers by Temperature," were based on a proposal sponsored by the A.I.E.E. Transformer Subcommittee of the Committee on Electrical Machinery that is intended to serve as a guide in operating transformers by temperature rather than in accordance with their nameplate ratings. These recommendations are:

Limiting Observable Temperature of Oil—The oil in which apparatus is permanently immersed should under no circumstances have a temperature, observed by thermometer, in excess of 90 deg., C.

Operation at Rated Load—Apparatus conforming with the A.I.E.E. standards for rating is suitable for carrying rated load continuously provided that the temperature of the cooling medium does not exceed 40 deg. C. for air or 25 deg. for water.

Operation With Cooling Air and Water Exceeding 40 Deg. and 25 Deg. C., Respectively—For apparatus conforming with the standards for rating, the load should be reduced 2 per cent below the rated load for each degree that the temperature of the cooling air exceeds 40 deg. or that the temperature of the cooling water exceeds 25 deg. However, the use of apparatus in cooling air exceeding 50 deg. or in cooling water exceeding 35 deg. shall be considered as special.

Operation at Loads Greater Than the Rated Load—Apparatus not equipped with a winding-temperature indicator may be loaded continuously 1 per cent above rated load for each degree Centigrade that the temperature of the cooling medium is below 30 deg. for air or 25 deg. for water.

Thus when the temperature of the cooling medium is 0 deg. C., the permissible continuous load is 130 per cent of rated load for air-cooled apparatus and 125 per cent of rated load for water-cooled apparatus.

Loads greater than 130 per cent of rated load for air-cooled apparatus or 125 per cent of rated load for water-cooled apparatus shall not be applied under any conditions even though the temperature of the cooling medium be lower than zero.

Apparatus equipped with a winding-temperature indicator may be loaded continuously in excess of rated load provided the indicated winding-temperature does not exceed the following limits for indicators marked in terms of:

Hottest spot temperature	95 deg. C.
Embedded detector temperature	90 deg. C.
Resistance method temperature	85 deg. C.

Oil temperature alone is an inadequate criterion of the winding temperature, because of the increased temperature drop through the insulation at low temperatures of the cooling medium and of the time lag between the winding and oil temperatures. Loading apparatus on the basis of oil temperature alone as a guide is not recommended.

Tests on High-Pressure Pipe Bends*

By Prof. William Hovgaard
Massachusetts Institute of Technology

In MY recent tests on high-pressure pipe bends supplementing those previously made on pipes designed for moderate steam pressures (reported in the M.I.T. *Journal of Mathematics and Physics*, Vol. VI, No. 2, 1926, and Vol. VII, Nos. 3 and 4, 1928) Huggenberger tensometers were used in addition to Berry strain gages for measurement of the longitudinal strains, and they appeared to be very satisfactory. The results corroborated with those obtained from more thinly walled pipes.

An alternative and simpler theory for calculating the stresses was advanced, embodying a modification of the formulas. This however did not alter, but rather gave additional support to, the principal conclusions advanced in previous papers. According to this theory the longitudinal stress is practically constant throughout the wall thickness at any point, and is determined by the same formula as given for the stress at the middle surface in previous analyses. This stress seems to dominate the behavior of the pipe bends and was chosen as a strength criterion.

It was found that for pipes made of ductile low-carbon steel or iron of good quality, no appreciable permanent set was likely to occur so long as the maximum longitudinal stress did not exceed 20,000 lb. per square inch, but a working stress of 16,000 lb. per square inch is recommended to allow for minor local overstrains.

A special study was made of the strain lines and the permanent strains as well as the interaction between the elastic and plastic parts. Formulas are given for calculating the longitudinal stresses in a curved pipe due to internal pressure.

*M.I.T. *Journal of Mathematics and Physics*, Vol. VIII, No. 4, December, 1929.

A.S.H.V.E. Holds Record Meeting at Philadelphia

First International Heating and Ventilating Exposition Is Also Well Attended

THE thirty-sixth annual meeting of the American Society of Heating and Ventilating Engineers in Philadelphia, Jan. 27 to 30, proved to be the banner gathering of the society as a result of the interesting papers on the technical program and due to the fact that the first International Heating and Ventilating Exposition was held simultaneously with it at the Commercial Museum under the auspices of the society. The meetings held at the Benjamin Franklin Hotel were attended by 1,063 members and guests.

The first day was devoted to a meeting of the council, trips to heating and ventilating manufacturers' plants and the exposition. The first technical session was opened on the following morning by John Cassell, honoary chairman, who greeted the visiting members; L. A. Harding responded to this greeting on behalf of the society.

The tellers then reported that L. A. Harding had been elected president for the coming year; W. H. Carier, first-president; F. B. Rowley, second vice-president; and C. W. Farrar, treasurer. R. H. Carpenter, J. D. Cassell, A. Kellogg and J. Howard were elected to serve on the council, and C. B. Hains, W. T. Jones, James F. McIntire, A. C. Willard and F. N. Speller to the Research Committee.

Balancing Power and Process Steam

"Power From Process and Space-Heating Steam," by L. A. Harding, was the first technical paper presented. Where steam is employed for process work the boiler pressure is frequently determined by that part of the process requiring the highest temperature, and geneally the bulk of the steam is used at lower temperature and pressure.

The more or less fixed amount of process steam available at existing process pressure is often found to be inadequate to supply all of the power requirements, and some means should be adopted to secure as near a balance between the heat available and the heat equivalent of the power requirements as it is possible or practical to obtain with a minimum of expense for extra fuel.

The heat available per pound of steam may be increased by (1) increasing the initial pressure, (2) superheating, and (3) decreasing the back pressure.

The comparative effect on the basis of per cent gain from initial conditions of 135-lb. dry saturated steam exhausting to process at 40 lb. was given in charts accompanying the paper. Curves were presented giving the ideal steam rates for initial pressure up to 600 lb. and with varying back pressures.

The discussion emphasized the necessity of using daily load curves for weekly periods, and also pointed out the opportunities for using accumulators to help even out the differences between power and process demands.

Air Leakage and Wind Velocity

At the Monday afternoon technical session, two inter-related papers were presented, one on "The Pressure Difference Across Windows in Relation to Wind Velocity," by J. E. Emswiler and W. C. Randall, and the other on "Air Infiltration Through Various Types of Brick Wall Construction," by G. L. Larson, D. W. Nelson and C. Broaty. The latter reported tests conducted to determine the air leakage through 13-in. brick walls for various pressure differences, and indicated a leakage of 2 cu.ft. per hour per square foot of bare wall with a pressure difference of 0.1 in. of water.

At the Wednesday morning session a paper by F. B. Rowley, A. B. Algren and J. L. Blackshow was presented which gave results of tests made to determine the effect of air velocities on surface heat conductance coefficients.

Other papers presented at this session were "Absorption of Solar Radiation in Its Relation to the Temperature, Color, Angle and Other Characteristics of the Absorbing Surface," by F. C. Houghton and Carl Gutberlet; and "Preventing Condensation in Interior Building Surfaces," by P. D. Close. The latter included a chart for calculating the amount of insulation necessary to prevent condensation where manufacturing processes required high humidities.

Research Activities

T. J. Duffield was appointed executive secretary of the Committees on Research, and revisions to the by-laws governing the research activities of the society were adopted after considerable discussion. Ten per cent of the exposition revenue was donated to the society's research activities.

J. C. Fitts reported the work and progress made by the Association for Correlating Thermal Research, which was organized in May, 1928. This Association, whose purpose is preventing duplication of research effort in this field, has indexed 4,000 pieces of literature dealing with thermal engineering. Information regarding the index may be obtained from the A.S.H.V.E. Research Laboratory, Pittsburgh.

At the afternoon session a standard code for testing and rating steam unit heaters was presented by the joint code committees of the Industrial Unit Heater Association and the A.S.H.V.E. There was much discussion on the code, and amendments were suggested regarding methods of checking air flow by direct measurements, and methods of calculating results. The code was finally adopted with an amendment making a check of air flow through the heater by nozzle mandatory instead of optional. L. S. O'Bannon presented a paper dealing with a method of testing unit heaters that is suitable to field use.

Thursday morning was largely devoted to reports of committees on boiler rating, garage ventilation and natural ventilation.

The continuing committee on the rating and testing of low pressure heating boilers presented a report which contained suggested revisions to the rating code adopted at the January, 1929, meeting. Action will be taken by letter ballot on the rating code as adopted by the Steel Heating Boiler Institute, and a rating code for warm air furnaces for gravity circulation. C. E. Bronson presented a paper entitled "The Rating of Boilers by Their Physical Characteristics."

Panel Warming

At the afternoon session a paper by L. W. Fowler describing "Panel Warming" was presented. In this system of heating, apparently becoming popular in England, pipe coils of ½ to ¾ in. diameter are embedded in the ceiling or walls. Water at 120 to 130 deg. is circulated through them and the walls and ceiling thus heated. It is claimed that this promotes better health, as it permits of lower air temperatures without discomfort.

A paper by F. I. Raymond and R. D. Lambert described a new method of automatically controlling the steam input to a heating system in proportion to outside temperature. The control element consists of a Bourdon tube that operates a mercury switch which in turn controls either the boiler output or, in the case of central station steam, the steam supply valve. The Bourdon tube is operated by the expansion and contraction of liquid in their bulbs, one of which is placed outdoors. The other two are attached to the last radiator. The total expansion of the liquid in the three bulbs determines the action of the tube. When the outside temperature is low the liquid will contract and the radiator must heat to a high temperature to move the switch to the off position. In this way a fractional part of the radiator is heated, as required by outside temperature.

It was announced that Thornton Lewis, president of the York Heating & Ventilating Corporation, of Philadelphia, has set up an endowment of $1,000 to be given each year to the member under 30 years of age presenting the best paper on heating or ventilating.

At the closing session Friday morning three papers were presented. The first had to do with friction losses and static pressures in domestic hot air systems. The second, by L. L. Lewis and A. E. Stacey, described the air conditions of the halls of Congress. The third, by A. I. Brown, presented performance data on disk and propeller fans.

The summer meeting of the society will be held June 23-25 at Minneapolis, Minn.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

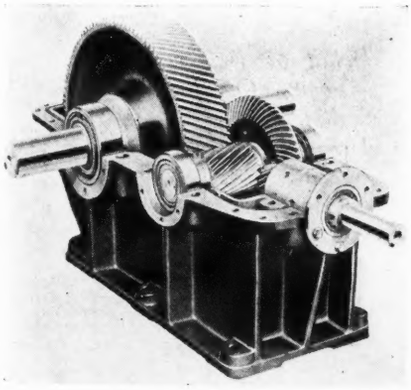
Right-Angle-Drive Speed Reducer

TO THE line of parallel shaft drives put out by the Falk Corporation, Milwaukee, Wis., has recently been added a line of right-angle-drive speed reducers in horizontal and vertical shaft types.

One feature of the right-angle drive is a combination of single helical and spiral bevel gears. It is pointed out by the manufacturer that single helical gears for the final reduction are easier to assemble than herring-bone gears and that their efficiency is practically the same.

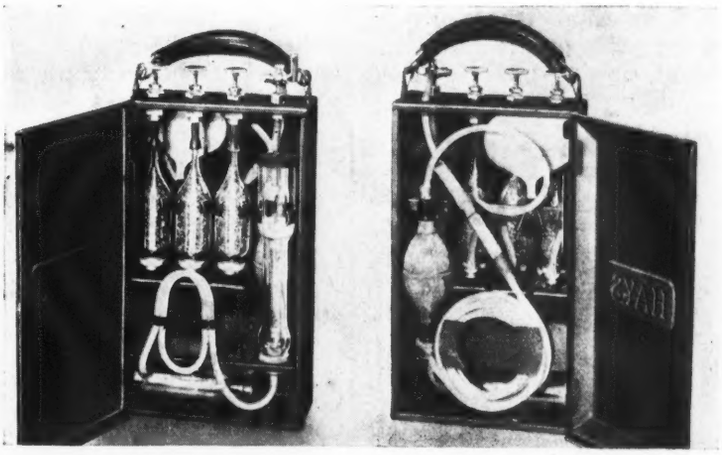
Another important feature is reversible construction of gears and shafts. If the gears become worn after years of service, the shafts can be turned end for end to permit using the opposite, unworn, sides of the teeth.

As in the parallel shaft reducers made by this company, the lubricating system of the right-angle units is simple and self-contained. It gives complete lubrication of the working faces of the gear teeth at all speeds and rapid circulation of oil through the bearings. A complete line of welded-steel motor beds has been developed to accommodate all motors coming within the capacities of the reducers.



Speed reducer with single helical and spiral bevel gears

Ratings on the new line range from $\frac{1}{16}$ hp. at 100 r.p.m. on the smallest unit to 565 on the largest. Ratios are from 1.5:1 to 518:1.



Front and rear view of improved gas analyzers mounted in carrying case

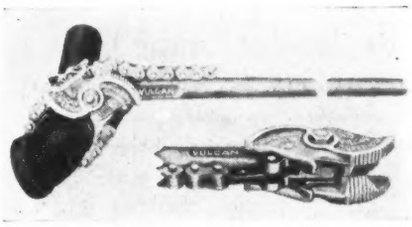
Improved Portable Gas Analyzer

AN IMPROVED line of portable gas analyzers has been announced recently by the Hays Corporation, Michigan City, Ind. Six standard ranges are available in a light-weight metal carrying case weighing 8 lb. complete and measuring 15 in. high, $7\frac{3}{4}$ in. wide and $4\frac{1}{4}$ in. deep. In addition there are three special ranges in a slightly larger case. Metal for the case is stamped out of Toncan iron and assembly is made by electric spot-welding.

The accompanying illustrations are front and rear views of the case with the doors open to show the compact arrangement. It will be seen that heavy molded-glass absorption pipettes are attached to molded hard rubber chemical bottles by soft rubber gaskets and finger compression nuts. Monel metal needle valves and removable nickel seats replace pinch clamps and glass stop cocks. The hard rubber chemical bottles are held in place by a sliding flat spring which can be raised, after loosening the holding screw, to dismantle the entire instrument.

After completion of a test the leveling bottle and the aspirator and tubing are clamped inside the case, the tubing being wound on reels to prevent kinking.

Use of steel wool surface to absorb the gases being analyzed makes it possible, according to the manufacturer, to take a CO_2 reading in 30 sec. and a complete analysis for CO_2, O_2 and CO in from 4 to 5 min. The instrument may be carried in any position without the liability of spilling or mixing the solution. Owing to the method of supporting the few glass parts in the metal case, there is comparatively little danger of breakage, and all parts are readily renewable in the field.



Application of wrench to a fitting, and detail of jaw

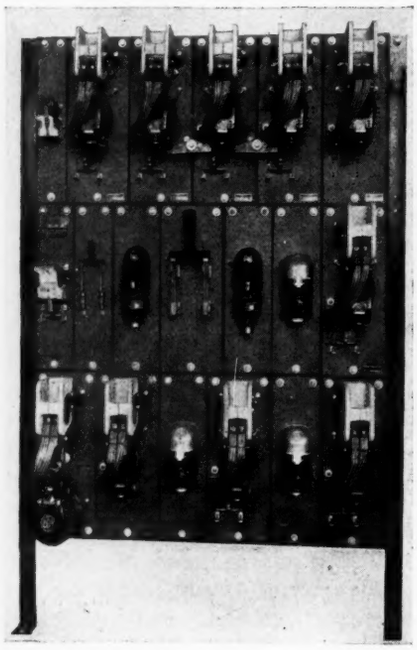
Chain Tongs for Pipe and Fittings

REVERSIBLE JAWS with a toothed recess making the wrench as readily adjustable to fittings as to pipe is a feature of the new pipe wrench designated "Vulcan Superior" recently introduced by J. H. Williams & Company, Buffalo, N. Y.

As will be clear from the illustration, the parallel curved jaws are for use on pipe, while the toothed recess

between the jaws assures positive grip on fittings. Thus, two tools are combined into one, obviating the need of having separate tools for this work.

The reversible jaw feature materially increases the life of the tool. The change from the teeth first in use to a new jaw is made simply by unscrewing the bolt and turning the jaws end for end. Tongs equipped with either cable or flat chain, in a number of sizes to take pipe from $\frac{1}{8}$ to 12 in., inclusive, are available.



"Wright" dynamic lowering circuit controller

Dynamic Braking Controller for Crane Hoists

ONE OF the principal troubles heretofore with dynamic braking hoist controllers has been sluggishness of the solenoid brake in the lowering direction, making it necessary to pause on the first point to give the brake an opportunity to release before advancing the controller, frequent brake adjustment being necessary to prevent entire failure of the brake to release.

The new dynamic braking controller for crane hoists illustrated, recently brought out by the Electric Controller & Manufacturing Company of Cleveland, Ohio, has been especially designed to eliminate this trouble. Instead of passing only one-third of the line current through the brake on the first point lowering, this new circuit passes all of the line current through the brake. The operator no longer has to hesitate on the first step: he can move the master controller instantly to any desired speed point. Improper brake adjustment has little effect on this quick release.

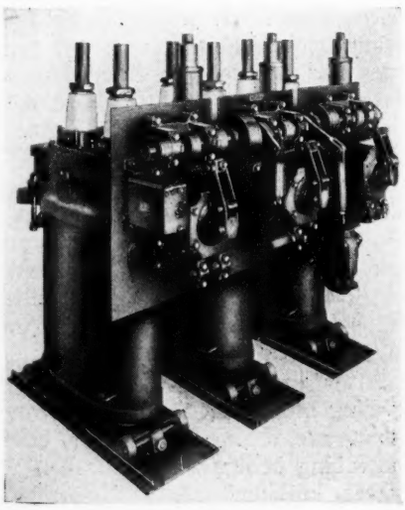
This improvement insures faster operation, more accurate control of short, quick movements and better ability to spot loads. The new controller is of the magnetic contactor type and is suitable for use on crane, coal bridge and bucket hoists.

Indoor-Type Oil Circuit Breaker

AN OIL CIRCUIT BREAKER known as Type F-110, of relatively high interrupting capacity and comparatively small over-all dimensions, has been brought out by the Condit Electrical Manufacturing Corporation, Boston, Mass.

It is of the indoor type, designed for cell structure, truck or platen mounting, for 2,000 amp. or less at 15,000 volts, with an estimated interrupting capacity of 10,000 amp. at 15,000 volts. The frame or pole top is of heavy construction to afford the rigidity necessary to assure proper functioning of the mechanism and strength to resist unbalanced stress and strain. The tank is elliptical in shape, welded at ends and bottom and equipped with suitable lining. Main current-carrying contacts are inverted laminated brushes specially designed to withstand extremely high inrush currents.

Quick-clearing, high-speed interruption is secured by an arcing contact structure, which combines the advantages of magnetized arc zones, thermal absorption capacity and occluded contacts.

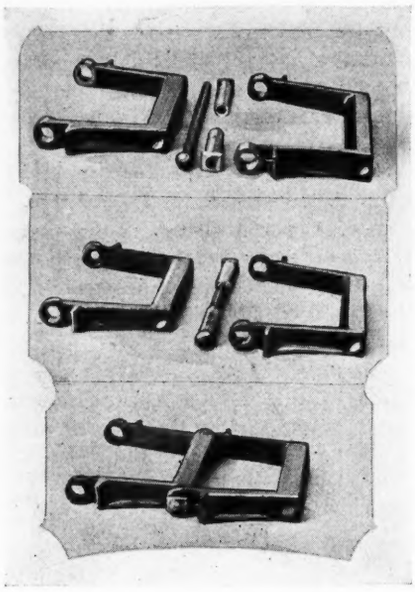


Type F-110 oil circuit breaker

Improved Conveyor Chain

A NEW conveyor or drag chain for handling refuse or any other material that can be handled by this type of chain has recently been developed by the American Manganese Steel Company, Chicago Heights, Ill.

The links are made from manganese steel. Instead of the usual steel pin or rivet running clear through the body of the link, each link is supplied with two manganese steel bushings, one for each eye of the link. These are held in place by a steel pin passing through them in the link barrel. This bushing arrangement enlarges the bearing surface and does away with the bowing and distorting common to the regular steel pins (with its consequent elongating of the chain pitch) and the trouble in removing or replacing the pins when worn.

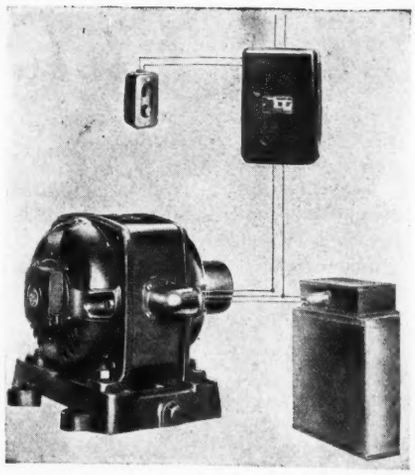


Detail of link and method of connecting links together

Single-Phase Capacitor Motors

A LINE of single-phase, squirrel-cage capacitor motors, designated Type KC, especially designed for quiet operation in driving blowers, ventilating fans and similar equipment, has been introduced by the General Electric Company, Schenectady, N. Y.

Although classified as a single-phase machine, it is a modified two-phase squirrel-cage motor with a capacitor in series with one phase of the stator windings. Like the two-phase squirrel-cage motor, it is



Motor with capacitor connected in one phase

self-starting. The capacitor remains in the circuit throughout starting and running, so that full-voltage hand or magnetic control only is required.

Available ratings in the line are from 1 to 25 hp., inclusive, at 3,600, 1,800, 1,200 and 900 r.p.m. constant speed, with starting torque from 60 to 40 per cent of full-load running torque, depending upon speed.

New Clutch Gives Slow Acceleration and Prevents Overload

THE ABILITY to let the motor or other prime mover to which it is connected come to speed without load and then gradually accelerate the driven machine is a feature of a new type of clutch put out by A. B. Pulvis, Stockholm, Sweden, and now being introduced in this country.

Referring to Figs. 1 and 2, which show a pulley-type clutch assembled and unassembled, the winged hub or wheel *A* is fitted to the shaft of a motor or other prime mover and the cylindrical housing *B* is connected directly to the shaft of the machine or by means of a belt or other form of transmission.

As will be clearly seen from a study of Fig. 2, the interior of the cylindrical housing or outer member *B* is corrugated, and the winged hub

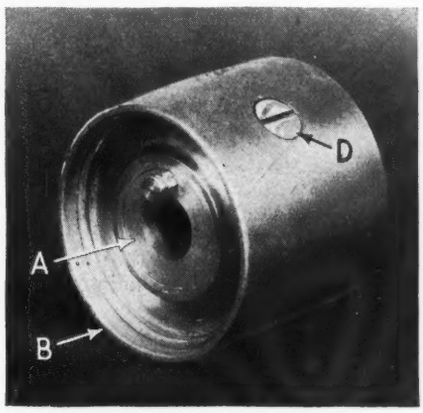


Fig. 1—Clutch assembly

A is free to revolve within it, there being no definite connection between the two.

Power is transmitted between the two members by a steel powder which partially fills the annular space between them. In operation the powder forms in drifts ahead of the wings, as shown in the schematic illustration, Fig. 3, and by centrifugal force the density of the powder drift is increased to a point where the friction on the corrugated surface of the

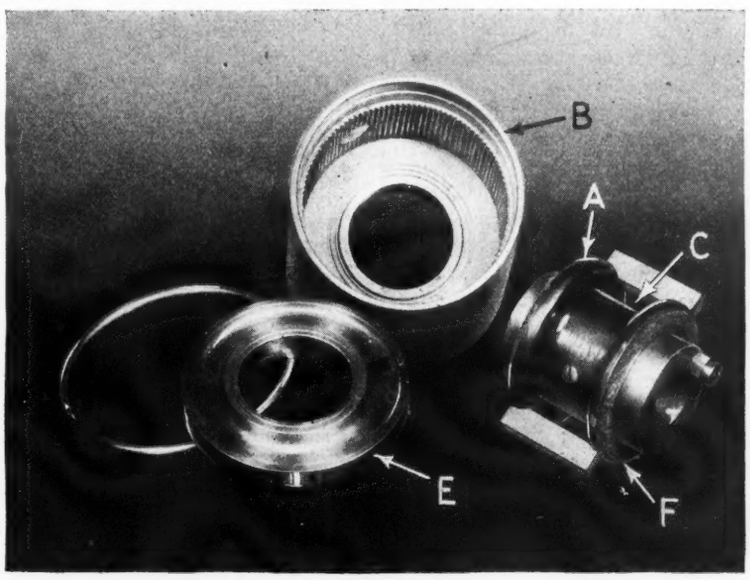


Fig. 2—View of clutch dismantled

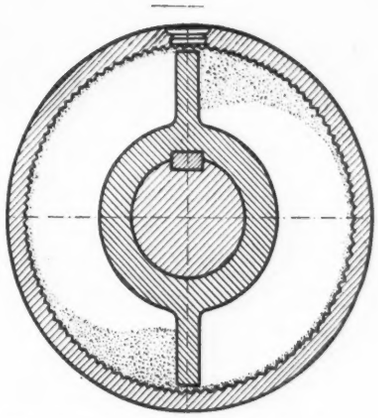


Fig. 3—Schematic diagram showing how powder forms in front of wings

housing is sufficient to hold the two members stationary in relation to one another. When this point is reached they run at the same speed as long as the power required to drive the load is less than or equal to the power which a given quantity of powder is capable of transmitting from the wings of the hub *A* to the housing *B*.

If the load on the driven machine increases above the point for which the coupling is designed the machine simply slows down, while the motor continues to run at approximately normal speed. As soon as the load is reduced to normal the machine is again accelerated to the speed of the motor.

The powder may be of various kinds, and by changing its qualities practically any accelerating characterisitc can be obtained.

To permit uniform distribution of the powder between the wings of the hub *A*, the wings are provided with openings *C*. Powder is poured in or drawn off through the opening *D*, which is closed with a screw plug.

In addition to the pulley type illustrated, the clutch is made for a straight-through drive on direct-connected units and in other designs to meet practically any kind of service, one being where the wings are hinged to make them automatically collapsible inward into an inactive position.

In the model shown the housing *B* is provided with the covers *E*. On the inner side of each there is a labyrinth seal which faces the felt rings *F* in the hub *A*. The center openings of the covers are bronze-lined and form bearings for the finished ends of the winged hub. The covers are held in place by expanding steel rings. Captain Nils Wallenius, 114 East 52nd St., New York City, is the American representative.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Spot * News

INDUSTRIAL PLANTS *at Niagara Falls are faced with a shortage of power due to the lack of action by the Senate on a treaty with Great Britain, which allows additional diversion at the falls, according to a statement of the New York public service commission, issued Jan. 29. Canada has already ratified the treaty.*

* * *

THE EDISON MEDAL, *highest award of the American Institute of Electrical Engineers, was formally presented the evening of Jan. 29 to Prof. Charles F. Scott of Yale by Harold B. Smith, president of the institute.*

* * *

A COMPREHENSIVE POWER PLAN *for the whole of Southwest England and South Wales has just been prepared by the British Electricity Commissioners and put in the hands of the Central Electricity Board for carrying into effect. The scheme provides electricity for an area of 17,234 miles by linking six existing power stations with two new ones, to be erected.*

* * *

ENDORSEMENT *of the hydraulic laboratory bill by Major-General Lytle Brown practically insures passage of this measure, which has been before Congress since 1922. While the Senate has been favorable from the beginning, the House committee on rivers and harbors has not been willing to override the disapproval of the former chief of engineers.*

* * *

A POWER CABLE, *described as the largest in Italy and one of the largest in the world, has just been placed in service between the Cardano generating station, at Bolzano, and the industrial centers of Lombardy and Piedmont. Over 150 miles in length, the cable transmits current at 240,000 volts.*

State Line to Install Two 1,200-lb. Units, Adding 275,000 Kw. to Capacity

PLANS for enlarging State Line Generating Station, on Lake Michigan, have just been announced, to the effect that two new turbine-generators to operate on steam at 1,200-lb. pressure are to be installed. These two units, with their complement of boilers, will comprise the second section of the station. In conjunction with the initial 208,000-kw. unit that went into operation during the past summer, they will give a total generating capacity of 483,000 kw. One of the new units will be a 150,000-kw. (at 90 per cent power factor) General Electric machine, and the other an Allis-Chalmers 125,000-kw. (at 85 per cent power factor) turbine-generator.

Contracts have been placed with the Babcock & Wilcox Company for the boiler equipment consisting of three boilers per unit, one of which will be a reheat boiler. The standard boilers will have a maximum capacity of 500,000 lb. per hour each and the reheat boiler an equivalent capacity in total heat production when the reheater is included. As in the initial installation, they will be equipped to burn pulverized coal, using unit mills of the pusher type with capacities from 15 to 17 tons per hour per boiler.

The addition of this second section, which will take about two years to complete, will make State Line Station the second largest in the Chicago district and the first to use steam at 1,200 lb. pressure. It will be recalled that this station has been planned from the beginning for a total capacity of at least 1,000,000 kw. The station is a wholesale producer of electrical energy on a large scale, the entire output being taken by the Commonwealth Edison Company, Public Service Company of Northern Illinois, Northern Indiana Public Service Company, and the Interstate Public Service Company.

N. Y. Steam Main Bursts

FOR the second time in six months a steam supply line under the streets of New York City burst. This time it was an 18-in. main of the New York Steam Corporation, carrying a pressure of 135 lb., under Cliff Street in the downtown section of the city.

The blast tore a 10-ft. hole in the pavement, tossing cobblestones about like pebbles, and steam shot up in the air several hundred feet. Three policemen narrowly escaped serious injury from the flying débris. Windows were blown in and steam forced its way into cellars.

Emergency crews from the steam corporation searched for more than an hour in manholes before they located a master valve to check the deafening roar of steam. Inspection afterwards showed that underground structures were not seriously damaged by the explosion.

Smoke Ordinance Drafted for Baltimore

A smoke-control ordinance calling for the establishment of a new municipal bureau headed by a smoke commissioner and including a smoke advisory board has just been drafted for the City of Baltimore, Md., by its Association of Commerce. According to the proposed measure, the mayor would appoint a smoke commissioner "who shall be an engineer qualified in the theory and practice of construction and operation of steam boilers and furnaces, and in smoke abatement." The mayor would also name the ten members of the unsalaried advisory board from nominations made by civic organizations, local chapters of the American Society of Mechanical Engineers, American Institute of Architects and American Chemical Society, the Engineers' Club of Baltimore, and the engineering department of Johns Hopkins University.

The new bureau of smoke control would form a part of the city's Department of Public Works. Duties of the commissioner would include "formula-

tion of standards, rules and regulations for inspection and control of the installation and reconstruction of fuel-burning equipment." He would issue permits for any power or heating plant using solid or liquid fuels in all types of buildings, and would supervise all mobile plants within the city limits.

Smoke "in harmful or damaging quantities" is defined as being equal to or denser than No. 3 of the Ringelmann chart. The measure provides for a fine of from $10 to $100 for every day that a smoke nuisance is allowed to continue.

New Additions to Steam Stations

Engineering work for a $1,000,000 addition to the Weleetka power plant of the Public Service Company of Oklahoma, Tulsa, is in progress and construction is expected to begin about Feb. 1. The installation will include a 15,000-kw. turbine-generator unit to be supplied by Westinghouse, and two 10,000-sq.ft. Stirling type boilers complete with air heaters.

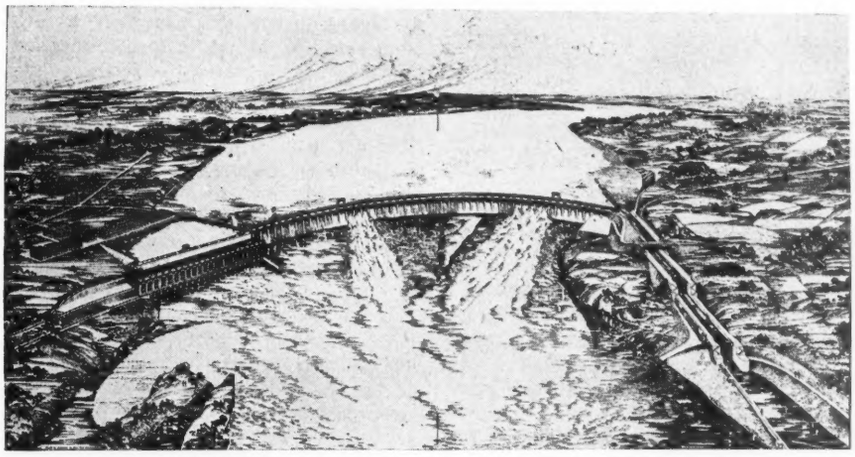
Westcott & Mapes, consulting engineers, of New Haven, Conn., are now engaged in designing and constructing additions to the English station at New Haven and the Steel Point station at Bridgeport, of the United Illuminating Company. An additional 12,500-kw. unit will be placed in each. At English station the sea wall is being extended to provide more coal-storage capacity.

Plan Large Hydro Turbines for Swedish Station

Plans are being prepared by the Swedish State Water Power Board for the erection of a hydro-electric power plant at Värgon, on the Gotha River, and the installation of two turbines with a total output of 20,000 hp. on a head of 14 ft. These turbines will be among the largest in the world as regards diameter of the runner and quantity of water utilized, the former to be 26.25 ft. and the latter 530,000 cu.ft. per minute for each unit. They will be of the vertical-shaft propeller type, with direct-connected generators.

The development is part of a plan to meet seasonal power requirements by regulating the flow of water from Lake Vänern, the third largest lake in Europe, into the Gotha River. It is proposed to dam up the lake 1.64 ft. above the mean level and to regulate the discharge by dams at Värgon, an island situated at the mouth of the river. The reservoir thus obtained will probably be the largest in existence, having an area of 2,165 square miles and a circumference of 2,700 miles. When completed, the project will make possible the storage of water during the summer, when power requirements are low, thereby allowing an increased output during the winter, when demands are greatest.

First Four 80,000-Hp. Hydro Turbines Ordered for Huge Russian Plant



Artist's sketch of Dneiper River hydro-electric project, which will have an installed capacity of 800,000 hp. when completed

FOUR 77,500-kva. hydro-electric generators, the largest in the world, are being manufactured by the General Electric Company for the Dnieper River development at Kichkas, near Zaporozhe, in the Ukraine. The development will supply power in the vicinity of Dnepropetrovsk, and through the southern part of the U. S. S. R.

The total weight of each generator will be approximately 1,760,000 lb., while the weight of the rotor and shaft will approach 980,000 lb. The maximum diameter is approximately 42 ft., while the generators will have an over-all height of 40 ft. 5 in., of which 17½ ft. will extend above the floor of the plant. Large castings have been eliminated by the use of fabricated welded construction.

Because of shipping limitations, the stator of the generator will be made in six sections, the punchings and windings to be assembled in each unit at the factory. The rotor will be completely dismantled for shipment. The heaviest single piece to be handled will be the 40-in. steel shaft, 36 ft. long, with a coupling flange on the end 70 in. in diameter. This part will weigh about 136,000 lb. It will be shipped on a special car, as will the hub for the upper bearing bracket, which is 16 ft. in diameter.

All of these vertical generators will be driven by water turbines being built by the Newport News Shipbuilding & Dry Dock Company. Hugh L. Cooper & Company, consulting engineers, of New York City, are now at work on the construction of the dam and power station.

Midwest Coal Conference at Purdue, April 9-11

Topics of interest to bituminous coal producers, distributors, manufacturers of coal-burning equipment and consumers will be discussed at the Midwest Bituminous Coal Conference, to be held under the direction of the Engineering Schools of Purdue University, the Coal Trade Association of Indiana and the Illinois Coal Bureau, at Lafayette, Ind., next April 9-11. This three-day educational conference is the outgrowth of the Indiana Fuel Conference which has been offered by the university for the past two years.

The program is being arranged by a committee consisting of Jonas Waffle, Coal Trade Association of Indiana, Terre Haute, Ind.; A. W. Cole, Purdue University; and B. R. Gebhart, Illinois Coal Bureau, Chicago. W. A. Knapp, Engineering Extension Department, Purdue University, is general chairman.

Two New Steam Plants for Pacific Coast

Construction of a 35,000-kw. steam generating plant at an estimated cost of $3,500,000 by the San Joaquin Light & Power Corporation, Fresno, Calif., was announced last month by A. Emory Wishon, vice-president and general manager. Work will start by March 1, and the schedule calls for completion of the project by June, 1931. Harold K. Fox, chief construction engineer for the San Joaquin and Great Western companies, will design and build the plant, which will be of the single-unit type, housed in modern steel and concrete buildings. Natural gas will be used as fuel, although the boilers also will be equipped to burn oil if necessary. The plant will follow the same general design as the new India Basin steam plant just completed by the Great Western Power Company.

Plans for a $2,000,000 steam generating plant to be built by the City of

Tacoma's (Wash.) municipal lighting and power department are being completed by engineers of the lighting department at this time, and official call for bids for the turbine-generator and accessory apparatus, including transformers, oil circuit breakers, switchgear, and other equipment will be made in the near future. Bids for the turbine-generator will probably be called in about ten days, with the calls for the other apparatus following shortly. The steam plant, developing 25,000 kw., will supplement the hydro-electric developments at La Grande and Lake Cushman plants owned and operated by the City of Tacoma.

Washington Plans 240,000-Hp. Hydro Plant

Completion of a tentative draft of the final plans for the development of the hydro-electric site at Kettle Falls on the Columbia River in northeastern Washington and the filing of these plans with the Federal Power Commission with the application for the issuance of a license have been announced by Miles W. Birkett, vice-president and general manager of the Washington Water Power Company.

This company acquired the site July 1, 1921, and since that time has been engaged in exploration of the site with the view of installing a hydro-electric development. Kettle Falls is about 40 ft. in height, and an ultimate head of 75 ft. can be secured through damming. The Columbia River at this point has a low water flow of about 20,000 sec.-ft. and a flood of about 300,000 sec.-ft. The development is planned in ten stages, with a 35,000-hp. initial installation and an ultimate development at about 240,000 horsepower.

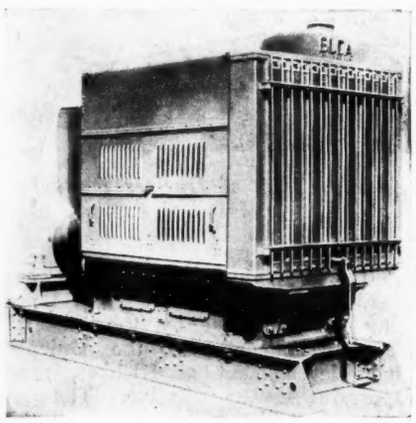
The plans for the project are now being gone over in detail by Major John S. Butler of the war department, representing the Federal Power Commission, and Victor H. Greisser, chief engineer for the Washington Water Power Company.

Bill Introduced to Change Power Commission

A bill to amend the Federal Water Power act so that, as recommended by President Hoover, the Federal Power Commission would be set up as an independent board, with full-time commissioners, has been introduced in the House by Representative Celler. It proposes that the commission should consist of three men, appointed by the President for terms of seven years each, to receive $10,000 annual salary each and the other, the chairman, $12,500. The bill also provides for a technical staff and for an expert accountancy service to conduct the necessary audits of the books and to handle licenses of projects under the jurisdiction of the commission.

New Mexico Uses Diesels for Highway Work

Four 120-hp. Buda Diesel engines have just been shipped to the New Mexico Construction Company at Albuquerque, N. M., for use in connection with highway construction. Operating at speeds between 800 and 1,000 r.p.m., these units will drive stone crushers from a paper belt pulley through a disk type clutch. As shown in the illustration, the engines are mounted on skids, which enable them to be moved from one job to another with a minimum of effort. They are completely inclosed with a



One of the semi-portable power units

sheet-metal housing that may be locked at night to eliminate any danger of tampering.

Starting is handled through a special Bendix drive by a small two-cylinder, air-cooled gasoline engine mounted on the flywheel housing. This eliminates accessories and makes the units completely self-contained. The radiator is of the conventional automotive type, made in sections so that repairs may be made, in case of damage, without lengthy interruption to operation.

High Efficiency Guaranteed for Kaplan Turbines

A maximum efficiency of 90 per cent of the head is guaranteed for two vertical-shaft Kaplan water turbines recently ordered by the Grey Electric Power Board of New Zealand from Boving & Company, Ltd., London. These turbines are designed to develop 1,800 hp. under a net head of 36 ft. and 2,200 hp. when the head is later increased to 46 ft., at a speed of 300 r.p.m. They will be the first turbines of this type to be installed in either Australia or New Zealand.

Each runner will be 5 ft. 6 in. in diameter, with four blades of stainless steel, actuated by an oil-pressure servomotor contained in the runner boss, which is controlled by the governor through a long valve passing down the center of the turbine and generator shafts. The relative movements of the runner blades and guide vanes will be so adjusted after erection that for any guide-vane position the runner blades will be set for maximum efficiency. This gives the advantage of a flat efficiency curve with high speed.

The maximum guaranteed efficiency of the turbine is 90 per cent of the ultimate head of 46 ft., and the efficiencies at maximum load and at 500 hp. output are 88 per cent and 81 per cent, respectively. The efficiency of a propeller runner of equal capacity when developing only 500 hp. would be only 41 per cent. When the head is increased from 36 ft. to 46 ft. it will only be necessary to adjust the shape of the cam controlling the position of the runner blades relative to the guide vanes to obtain the maximum efficiencies.

Addition Planned for Glasgow Plant

The transport committee of Glasgow Corporation, Glasgow, Scotland, has recommended the acceptance of the offer of John Thomson, Ltd., Wolverhampton, for the installation of six boilers at its Pinkston power station. The tendering price quoted by the undertaking was $451,635, and of this sum one-fourth will, it is understood, be spent in the Glasgow district. The boilers are required for the extensions of plant planned not long ago, when the corporation decided it would be better to continue to take its street railway current from a station devoted exclusively to the traction undertaking rather than from the new power station at Dalmarnock, as was suggested by the Electricity Commissioners. The complete scheme of extensions at the Pinkston station involves an expenditure of about $1,092,500, and includes the installation of a new 18,750-kw. turbine-alternator, of which the Electricity Commissioners have refused to approve.

Chamber Power Committee Completes Survey

As a basis for its consideration of national procedure looking to the development of the country's water-power resources, estimated to be approximately 38,100,000 hp., the National Water Power Policies Committee of the United States Chamber of Commerce virtually completed its factual studies at a recent meeting in Washington. These deal only with a few of the more important questions involved in the rapid and orderly development of water power—such as sources and distribution, the relative importance of steam and water power, regulation, valuation, rate structures, interstate transmission and federal and state relationships in water-power development.

Preliminary conclusions drawn from these facts will be developed at once. Special attention was given to Muscle Shoals and a statement on this subject will also be submitted.

Lamme Medal Awarded To R. E. Hellmund

The Lamme Medal of the American Institute of Electrical Engineers has been awarded to R. E. Hellmund, East Pittsburgh, Pa., "for his contributions to the design and development of rotating electrical machinery." It is expected that the medal will be presented at the summer convention of the institute, which is to be held in Toronto, Canada, June 23-27.

Rudolf Emil Hellmund, chief electrical engineer of the Westinghouse

R. E. Hellmund

Electric & Manufacturing Company, was born in Gotha, Germany, Feb. 2, 1879. After receiving his early education in Gotha, he attended the Ilmenau Technical College, from which he graduated with honors in electrical engineering in 1898. He later took postgraduate work at the University of Charlottenburg.

Prior to his studies at Charlottenburg, Mr. Hellmund worked for some time as a designer of electrical machinery and spent one year in the laboratory of the Land-and-See Kabelwerke, Cologne. Subsequently, he was placed in charge of the test floor and laboratory of the Maschinenfabrik Esslingen, Stuttgart.

After his course at Charlottenburg, Mr. Hellmund came to the United States and was employed by the Krantz Company of Brooklyn as a designer of switches and switchboards. In 1904 he was employed by William Stanley of Great Barrington, Mass., with whom he worked on the design of induction motors and also did experimental work on self-compounding alternators. Following this Mr. Hellmund worked for the Western Electric Company at Hawthorne, Ill., designing a line of induction motors which was then marketed by that company. In 1907 Mr. Hellmund entered the employ of the Westinghouse company as a designer of induction motors. Later he was engaged in general engineering work, and in 1912 he was placed in charge of the design of all direct- and alternating-current railway machines.

Mr. Hellmund is the author of many papers which have appeared in the "Transactions of the A.S.M.E." and "Proceedings of the British Institution," and various other American and foreign technical magazines, covering such subjects as rotating fields and leakage fluxes in alternating-current machines, single-phase commutator motors, regenerative control for railways, electric traction, engineering education, etc.

He joined the A.I.E.E. in 1905, was transferred to the grade of member in 1909, and became a fellow in 1913. He is also a member of the German Electrotechnical Society.

Business Forecast

BUSINESS is warming up, as it should, from the bottom, and somewhat earlier or faster than was expected. This is dramatized by the blow-in of several blast furnaces for the first time in months. Steel production has expanded with surprising rapidity under the stimulus chiefly of automobile makers who think the market is good and are increasing schedules, preparing to try it out. Government reports are positive that employment has increased generally since the first of the year, which is not only gratifying but remarkable. Weakness in commodity prices, with the collapse of price pegging plans, however, is retarding buying activity, and freight traffic and general trade are about as active as they were during the painful early weeks of 1928 when Model A was being born.

Dr. Wynne Cites Progress of N. Y. Smoke Drive

At a recent luncheon of the American Institute of the City of New York, Dr. Shirley Wynne, health commissioner of the city, declared that the chief accomplishment in 1929 toward abating the smoke nuisance in New York was the creation of public opinion to support the campaign against this evil. After this year an enlarged program can be formulated with the knowledge that it will bring adequate returns in smoke abatement, he said.

He commended the Pittsburgh (Pa.) ordinance requiring the installation of periscopes in boiler rooms so the fireman, while at his post, can see how much smoke is being discharged into the air, and Pittsburgh's efforts to make manufacturers put correct ratings on their boilers. The commissioner said that most boilers are overrated, with the result that the fire is overstoked to meet heating needs and clouds of smoke are emitted.

Dr. Wynne said it had been estimated that smoke is costing New York City $96,000,000 a year.

News of Canada

Ontario and Quebec Agree on Carillon Project — Jordan River Contracts Awarded — Ruskin Cofferdams Completed

ONTARIO and Quebec are completing arrangements for the development of over 200,000 hp. of electric energy at Carillon, on the Ottawa River about half way between Ottawa and Montreal. This announcement was made by Premier Ferguson of Ontario, at a power conference held in Ottawa on Jan. 24, between representatives of the Dominion and the provincial governments. The two provinces are in agreement over the undertaking, and the arrangements for the actual physical structures necessary for the joint development of the power will be made between the Ontario Hydro-Electric Power Commission and the National Hydro-Electric Company, the holder of the small lease which was granted in 1911 and which is not terminable until 1974. The Carillon site is half in Ontario and half in Quebec.

This was the only definite announcement made concerning the conclusions reached at the conference, which was held in private. Nearly all the discussion is understood to have been devoted to search for some common ground regarding the relative rights of the Dominion and the provinces over water powers. There is no dispute as to the Dominion's authority over navigation, but there have always been differences as to the power possessions.

Jordan River Contracts Let

By the award of a contract for $55,000 to the Canadian Westinghouse Company for transformer equipment for the fourth unit of the Jordan River hydro-electric plant, the British Columbia Electric Company has completed the principal contracts for the installation. The contracts for waterwheel and generator were awarded to the English Electric Company, at a total contract price of $160,000. The Vancouver Engineering Works has contracted to erect the penstock at an outlay of $387,000. The company will spend an additional $200,000 in installation of the above equipment, the whole of the concrete supports for the pipe line, of nearly two miles in length, and the electrical work at the plant being done by its staff.

Ruskin Cofferdams Sealed

With sealing operations practically completed on the two cofferdams at Ruskin Gorge on the Stave River, B. C., the site of the permanent concrete dam, one of the main items in the newest hydro-electric development of the British Columbia Electric Railway Company, is now pumped dry and ready for excavations. The river was diverted from its original bed through a timber and concrete flume two months ago. Work is proceeding on the foundations of the power house, which is to be located on the east bank of the river.

Trade Commission Checking Interstate Power

Questionnaire returns showing the amount of power produced in each state during 1929, with particular attention to that passing over state lines, are fast being completed at the Federal Trade Commission. It is expected that the final results will be compiled within the next few weeks and transmitted to Senator Couzens' Committee on Interstate Commerce as directed by the Senate last November. All power producers listed by the statistical division of the United States Geological Survey have been sent blanks for this purpose by the commission's economic branch, and a large proportion of the replies already has been received.

This survey will check and supplement the study made by the National Electric Light Association for 1928, when it was found that only about 10 per cent of the nation's power output was transmitted over state lines and that of this quantity more than half was subject to regulation by state boards. The government figures may be considered as an impartial and independent check showing whether the trend toward interstate sales is increasing. Whether action will be taken by the committee on the small volume of electrical energy now passing state lines remains to be seen.

Coming Conventions

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers, District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

Engineering Institute of Canada. Annual meeting at the Chateau Laurier, Ottawa, Ont., Feb. 12-14, 1930. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill:

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Obituary

Francis Cole Pratt, former vice-president and chairman of the manufacturing committee of the General Electric Company, died Jan. 26 in New York City after an illness of six weeks. Born in 1867 at Hartford, Conn., he was graduated from the Sheffield Scientific School of Yale University with the degree of Ph.B. in mechanical engineering in 1888. After graduation he was associated with the Pratt & Whitney Company, machine tool manufacturers, of which his father was president and one of the founders, continuing with the firm until he became vice-president. Mr. Pratt joined the General Electric Company in 1906 as assistant to E. W. Rice, in charge of manufacturing and engineering. He was made assistant to the president in 1913 and was elected vice-president in 1919. As vice-president he at first had charge of engineering and later of both engineering and manufacturing. He retired in 1927.

Alonzo Robert Mullin, chief engineer of the Seattle (Wash.) Municipal Light Department's Lake Union steam plant, died suddenly on Jan. 17 following a heart attack.

Clarence W. Hodges, general purchasing agent of the Worthington Pump & Machinery Corporation, died suddenly on Jan. 17 at the Paterson (N. J.) Hospital, as the result of an operation. Born at Randolph, Vt., May 15, 1876, Mr. Hodges was graduated from Williams College with the class of 1900. For some years he was employed by the American Locomotive Company as purchasing agent, and since 1918 he had been employed in the same capacity by the Worthington corporation.

Personals

H. Birchard Taylor has been appointed representative of the American Society of Mechanical Engineers on the council of the American Standards Association, filling the vacancy caused by the expiration of the term of office of Stanley G. Flagg, Jr.

A. D. Skinner, president of the Skinner Engine Company, left New York City last week on a cruise to Panama for his health.

C. E. Bennett, general engineer of the Georgia Power Company, is at Piedmont sanitarium, Atlanta, Ga., recovering from an operation performed on Dec. 30.

W. G. R. Braemer, widely known air-conditioning specialist, has been appointed by the Niagara Blower Company to direct its Philadelphia office.

O. D. Treiber, president of the Trebier Diesel Engine Corporation, has been elected a vice-president of the Society of Automotive Engineers for 1930.

A. N. Cartwright, general superintendent of operations for the West Penn Power Company, has been promoted to operating vice-president in charge of all maintenance and engineering having to do with generation, transmission and distribution. Mr. Cartwright has been with West Penn since 1903, having been in charge of various engineering and construction activities during this time.

Stuart M. Crocker, who on Jan. 1 resigned as vice-president and treasurer of the United Electric Securities Company to become assistant to the president of the International General Electric Company, has been elected vice-president of the latter company.

Edward H. Hubert, formerly an assistant secretary of the American Institute of Electrical Engineers, has been appointed director of publicity for the National Electrical Manufacturers' Association to succeed Albert Pfaltz, resigned.

Howard Fellows has been appointed assistant chief engineer of the Nova Scotia Power Commission. He will work under Harold S. Johnston and will have charge of electrical design for all the commission's developments.

Alexander D. Robb has been elected vice-president of the Niagara Electric Service Corporation, Niagara Falls, N. Y. Mr. Robb has been connected with the public utility industry for 25 years.

Business Notes

Ironton Fire Brick Company, Ironton, Ohio, announces the appointment of Stegall & Company as its representative in Chattanooga, Tenn.

Mason Regulator Company, Boston, Mass., has appointed the O'Brien Equipment Company, 2726 Locust Blvd., St. Louis, Mo., as exclusive distributors of its products in Missouri.

Wagner Electric Corporation, St. Louis, Mo., announces the transfer of L. J. Dicianne from the position of branch manager of the Minneapolis office to the branch-managership of the Kansas City office. Major Elam, salesman in the St. Louis territory, has been appointed branch manager of the Minneapolis office.

American Colloid Corporation has been formed for the purpose of manufacturing colloids for the treatment of boiler feed water with a main office at 15 East 26th St., New York City, and factory at Boonton, N. J. Officers of the new corporation are: E. F. Drew, president; E. J. Whitlock, vice-president and sales manager; George C. Reinhard, chief chemist; W. E. Hainley, plant manager.

General Refractories Company, Philadelphia, Pa., announces it has acquired all of the refractories, plants and business, including the vast clay lands in Missouri and Georgia, of the Evens & Howard Fire Brick Company of St. Louis, Mo.

Neilan, Schumacher & Company, Los Angeles, Calif., have appointed Patrick H. Heeney as their South American sales representative, with headquarters at Apartado 298, Maracaibo, Venezuela. Mr. Heeney is well known among South American oil men.

Duriron Company, Dayton, Ohio, and Industrial Welded Alloys, Inc., Newark, N. J., announce the consolidation of their sales and engineering activities. Incident to this affiliation, there has been a major enlargement of the parent Duriron plant at Dayton, and the erection of an Eastern foundry at Newark.

Howell Electric Motors Company, Howell, Mich., announces the purchase of the business of the Jeannin Electric Company, Toledo, Ohio. The manufacturing equipment of the Jeannin company will be moved to Howell.

Chain Belt Company sales for 1929 were just over $8,000,000, an increase of $900,000 over sales for 1928, according to C. F. Messinger, general sales manager. Earnings for 1929 will be about $7 a share.

With the Society Sections

American Boiler Manufacturers Association. Mid-winter meeting at the Cleveland Hotel, Cleveland, Ohio, Feb. 4.

A.S.M.E., Providence Section. Meeting in the Providence Engineering Society rooms, Feb. 4, at 8 p.m. Subject: "Bearings and Lubrication," by Dr. A. E. Norton, professor of mechanical engineering at Harvard University, Cambridge, Mass.

American Standards Association. Conference of manufacturers, distributors and users of leather belting to determine whether national standards shall be established, in Room 1105, Engineering Societies Building, 29 West 39th St., New York City, on Feb. 6 at 10:30 a.m.

Engineering Societies of Boston. Annual dinner and gala entertainment will be given at the Copley Plaza Hotel on Feb. 12.

Trade Catalogs

Stokers—A new catalog, MR-2, illustrating and describing the super-station type C-E multiple retort stoker has just been issued by the Combustion Engineering Corporation, 200 Madison Ave., New York City. An interesting feature of this publication is that it was produced by the aquatone process, as developed by the Printing House of William Rudge, and is said to be one of the first catalogs pertaining to industrial equipment to be printed in aquatone. Copies will be sent to those interested upon request.

Draft Gages—An attractive new 20-page catalog done in color, entitled "Standardizing Combustion Practice," has been issued by The Hays Corporation, of Michigan City, Ind., to illustrate the various features and combinations of the Hays pointer gages, with subsequent mention of Bourdon tube units for pressure, vacuum and temperature, and other Hays direct reading and recording gages.

Heating—A recent 24-page illustrated bulletin of Webster Tallmadge & Company, 50 Church St., New York City, discusses the many problems involved in the correct design of a heating system, shows how various typical service conditions may be successfully provided for, and explains in detail the special features of the Tallmadge system of zone heating with remote control. Several diagrams depict how proper distribution of heat may be obtained in many types of buildings.

Grates—Bulletin No. 109, just issued by Neemes Foundry, Inc., 220 First St., Troy, N. Y., completely describes and illustrates the improved types of Neemes shaking and dumping grates, also grates of special construction. Many illustrations show recently developed structural features and assembled installations.

Coatings—A descriptive circular and color chart on protective coatings has just been issued by the Quigley Furnace Specialties Company, 56 West 45th St., New York City. It contains many suggestions for improving the appearance of the power plant.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25 @$2.50
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.50 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.20
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.40@ 1.50

FUEL OIL

New York—Jan. 30, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Jan. 23, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.695 per bbl., or 42 gal.; 26@28 deg., $1.745 per bbl.; 28@30 deg., $1.795 per bbl.; 30@32 deg., $1.845 per bbl.; 32@36 deg., gas oil, 4.401c. per gal.; 37@40 deg., distillate, 5.23c. per gal.

Pittsburgh—Jan. 21, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.62½@4.75c.

Philadelphia—Jan. 17, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Jan. 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Jan. 21, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.02½@$1.07½ per bbl.; 30@32 deg., $1.30@$1.35 per bbl.

Boston—Jan. 25, tank-car lots, f.o.b., 12@14 deg., Baume, $1.05 per bbl.; 30@32 deg., 5c. per gal.

Dallas—Jan. 25, f.o.b. local refinery 26@30 deg., $1.35 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—F. & W. Grand, 5, 10 and 25 Cent Stores, Inc., awarded contract for a 6 story stores building at 537-41 South Broadway to Bavin & Burch Co., 173 East Jefferson St. Estimated cost $600,000. Steam heating system, elevators, etc., will be installed.

Calif., Los Angeles — Sun Realty & Finance Corp., 1680 Vine St., plans the construction of a 12 story office and stores building at 629-633 South Hill St., including steam heating system, elevators, etc. Estimated cost $750,000. C. Beelman, Union Bank Bldg., is architect.

Conn., Hartford—Southern New England Ice Co., 48 Edwards St., awarded contract for the construction of an ice manufacturing plant on Hamilton St. to Bartlett-Brainard Co., 252 Asylum St. Estimated cost $150,000.

Conn., New Haven—United Illuminating Co., 128 Temple St., is having plans prepared for addition to English station power plant and facilities, also addition to Steel Point power plant and turbine on East Main St., Bridgeport. Estimated cost to exceed $150,000 each. Westcott & Mapes, 139 Orange St., New Haven, are engineers.

Fla., Gainesville—Florida State Bd. of Control, P. K. Yonge, Chn., will receive bids until Feb. 17 for construction of a unit to central heating plant at University of Florida.

Georgia—Georgia Power Co., subsidiary of Southeastern Power Co., 120 Broadway, New York, N. Y., plans expansion of power plants, also power lines at various locations here. Estimated cost approximately $16,000,000.

Ga., Augusta—City is having surveys made for electrifying present municipal canal system and reserve steam or Diesel oil engine power plant to supplement present water power development on the Savannah River. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., is engineer.

Ind., Michigan City—Cosmopolitan Club, had plans prepared for the construction of an 8 story hotel, including steam heating system, elevators, etc., at Dunes Highway and Menter Ave. **Estimated cost $2,000,000. Markus & Gross, 208 Washington Blvd., Chicago, Ill., are architects.**

Ia., Winterset—City is having plans prepared for extensions and improvements to power plant. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

Kan., Kansas City—City is having plans prepared for extensions and improvements to light and power plant, including 10,000 kw. turbine and two 1,200 hp. boilers with auxiliaries. Estimated cost $3,000,000. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., is engineer.

La., Baton Rouge—Louisiana Steam Products Co., will build a steam power plant. Estimated cost $200,000. Work will be done by separate contracts. Equipment contract let.

Massachusetts—Worcester Suburban Electric Co., R. H. Alton, Mgr., Uxbridge, is having plans prepared for the construction of 13,000 kw. sub-stations at Saundersville, Millbury and Douglas, also transmission lines. Estimated cost $250,000. Private plans.

Mass., Dorchester (Boston P. O.)—Rubel Ice Corp., c/o A. W. Billings, Jr., 80 Boylston St., Boston, Archt., awarded contract for the construction of a 100 x 300 ft. ice plant to Antonio Rotelli, 681 Broadway, Providence, R. I. Estimated cost $100,000.

Mass., East Boston (Boston P. O.)—Boston Ice Co., 11 Deerfield St., Boston, awarded contract for the construction of a 1 story, 70 x 80 ft. ice plant on East Eagle St. here, to Vappi & Ferguson, 515 Massachusetts Ave., Cambridge. Estimated cost $80,000.

N. J., Jersey City—W. Neumann, 26 Journal Sq., Archt., will receive bids about Mar. 1 for the construction of a 15 office and stores building, including steam heating and ventilation systems, boilers, elevators, etc., at Newark and Oakland Aves. for Springarn Realty Co., 591 Summit Ave. Estimated cost $750,000.

N. J., Newark—City Center Corp., c/o Flanagan & Kennedy, 578 Madison Ave., New York, N. Y., Archts., is having preliminary plans prepared for the construction of an office building, hotel, etc. including steam heating system, swimming pool, skating rink, etc. at Farmers Market Plaza. Estimated cost $5,000,000.

N. Y., Brooklyn—Rubel Coal & Ice Co., 937 Fulton St., will receive bids until Apr. 1 for addition to ice plant at India Wharf and Conover St. Estimated cost $40,000. H. J. Nurick, 44 Court St., is architect, also awarded contract for an ice plant at 21st St. and Neptune Ave. to G. Jensen, 8124 11th Ave. $90,000.

N. Y., Glendale—Knickerbocker Ice Co., 41 East 42nd St., New York, has work under way on the construction of a 54 x 85 ft. ice plant at Proctor and Edsall Ave. here.

N. Y., New York—New York Central R.R. Co., 466 Lexington Ave., plans the construction of a 3 story, 38 x 62 ft. power house at Palisade Ave. and New York Central right-of-way. Estimated cost $50,000. F. B. Freeman, Ch. Engr.

N. D., Grand Forks — City plans an election Apr. 1, to vote $225,000 bonds for waterworks improvements including filtration plant, distribution lines, pump house, pumps, etc. E. J. Lium, is city engineer. Burns & McDonnell, Interstate Bldg., Kansas City, Mo., are engineers.

O., Cleveland—York House Co., c/o H. F. Neighbors, Pres., 2307 Chester Ave., is having plans prepared for the construction of a 10 story hotel, including steam heating, ventilation and refrigeration systems, elevators, etc., at 2708 Euclid Ave. Estimated cost $1,000,000. Fulton & Taylor, 8120 Euclid Ave., are architects.

Pa., Philadelphia—C. J. McIlvaine, c/o McIlvaine & Roberts, Otis Bldg., Archts., plans the construction of a 30 story office building at 17th and Lattimer Sts. Estimated cost $2,500,000.

Texas—Central Power & Light Co., Frost Bldg., San Antonio, is having surveys made for extensions and improvements to electric distribution system in towns of Comfort, Cotulla, Devine, Fredericksburg and Jourdanton, also additional equipment for plants. Private plans.

Texas—Circle Unit Farms, c/o R. A. Grand, Smith-Young Tower, San Antonio, is having plans prepared for irrigation project to include drilling water wells and installing pumping plant, etc. Estimated cost $2,000,000. Private plans.

Tex., Armarillo — City is having plans prepared for extensions and improvements to municipal light and power plant. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

Tex., Levelland—City will soon award contract for the construction of a waterworks system including pump house, pump, mains, etc. Estimated cost $60,000. Montgomery & Ward, Wichita Falls, are engineers.

Utah, Farnum—Carbon Dioxide & Chemical Co., c/o M. P. Smith, V. Pres., Salt Lake City, plans the construction of a dry ice plant for using carbon dioxide gas discovered on Farnum dome, here, present flow 12,000,000 cu.ft. daily. Estimated cost $100,000.

Wash., Anacortes—City is having plans prepared for the construction of a water supply system including pump house, storage facilities, lines, etc. Estimated cost $350,000. W. C. Morse & Co., Smith Tower, Seattle, are engineers.

Wash., Roy—City will soon receive bids for a waterworks system including pumping plant, operated by 7½ hp. motor, etc. Estimated cost $20,000. Miller Engineering Co., Burke Bldg., Seattle, is engineer.

Wash., Seattle—Gainsborough Investment Co., Lloyd Bldg., awarded contract for the construction of a 13 story apartment building at Spring St. and Miner Ave. to H. S. Wright & Co., 2410 First Ave. Estimated cost $600,000. Electric refrigeration, mechanical ventilation systems, etc. will be installed.

Ont., Port Arthur — Hydro-Electric Power Commission of Ontario, 190 University Ave., Toronto, plans the construction of third hydro-electric plant on the Nipegon River near here to develop 100,000 hp. Estimated cost approximately $5,000,000.

Ont., Toronto—Syndicate, c/o B. Brown, 600 Bay St., plans the construction of a 17 story loft building including steam heating system, elevators, etc. at Simcoe and Richmond Sts. Estimated cost $750,000.

Equipment Wanted

Boilers, Stokers, Breeching and Coal Handling Equipment—Cincinnati, O.—Bd. of Education, C. W. Handman, Bus. Mgr., Administration Bldg., 216 East 9th St., will receive bids until Feb. 10 for boilers, stokers, boiler breeching and coal handling equipment for Oyler School, Burns St.

Changers, Switchboards, etc.—New Orleans, La.—Sewage & Water Board, will receive bids until Mar. 20 for frequency changers, switchboards and accessories for sewage system.

Electric Switching Equipment—Detroit, Mich.—Bd. of Water Commissioners, W. T. Skrzycki, Pres., will receive bids until Feb. 12, for electric switching equipment for pumping and power plants of Springwells station

Generator—Boston, Mass.—New England Iron Works Co., 24 Fargo St.—arc welding generator, 200 amp., 1,200 or 1,800 r.p.m.

Generator and Engine—Utica, N. Y.—Dept. of Mental Hygiene, Albany, will receive bids until Feb. 19, for an electric generator and engine for Utica State Hospital here.

Pump and Motors—San Francisco, Calif.—Constructing Quartermaster, Fort Mason, plans the installation of a 100 g.p.m. pump and motors for proposed waterworks improvements.

Pump, Motor, Switchboard, etc. — Hanford, Calif.—City, D. C. Williams, Clk., will receive bids until Feb. 10 for furnishing and installing deep well pressure pump together with motor, switchboard, tank, etc., for proposed waterworks.

Pumps, etc.—Jacksonville, Ill.—Bd. of Local Improvements, City Hall, will receive bids until Feb. 20 for pumps, etc., for proposed sewage treatment work.

Pumps, etc.—Lucknow, Ont.—Town plans to purchase electric pumps, etc., for proposed waterworks improvements. Estimated cost $70,000.

Industrial Projects

Calif., Fresno — New England Sheet Metal Works, 301 Broadway, awarded contract for a 1 story, 50 x 140 ft. factory on San Benito St. to W. T. Harris, Fresno.

Calif., Los Angeles—Los Angeles Box Co., 3324 South Main St., awarded contract for the construction of a 1 story, 150 x 200 ft. factory at 2615 Pitt St., to W. Knowles, 1214 Webster St., Oakland. Estimated cost $45,000.

Calif., Los Angeles—Liquid Carbonic Co. of Chicago, 3100 South Kedzie Ave., Chicago, Ill., plans the construction of two factory buildings at Hostetter Industrial Dist. Estimated cost $100,000. Austin Co., 777 East Washington St., is architect.

Calif., Los Angeles—Mission Hosiery Mills, 3746 Moneta St., is having plans prepared for a 5 story, 63 x 94 ft. factory at 37th Pl. and Moneta St. Estimated cost to exceed $40,000. A. Monaco, 306 Pershing Sq. Bldg., is architect.

Conn., New Haven—F. Hertler, 118 Lawrence St., awarded contract for the construction of a bologna plant including cold storage plant on State St. to M. H. Teitelman, 42 Church St. Estimated cost $45,000.

Mass., Foxboro — The Foxboro Co., E. H. Bristok, Pres., is having preliminary plans prepared for addition to plant for the manufacture of gauges, controllers, recorders, thermometers, etc. on Neponset St. Estimated cost $40,000. Private plans.

N. J., Blackwood—Blackwood Silk Hosiery Co., awarded contract for the construction of a 1 story, 50 x 150 ft. mill to W. F. Latz, Frankford Ave. and Oxford Pike, Philadelphia, Pa. Estimated cost $50,000.

N. J., Camden—S. Langston Co., 6th and Jefferson Sts., plans the construction of a 2 story, 45 x 100 ft. factory for the manufacture of paper box machinery. Lockey & Herrel, 544 Federal St., are architects.

N. J., Kearny — Western Electric Co., 195 Broadway, New York, will soon award contract for the construction of factories, No. 40 E., 41 and 42 on Central Ave. here. Estimated cost $500,000. Private plans.

N. C., Charlotte—E. C. Griffith, Johnston Bldg., is having plans prepared for the construction of a 1 story, 60 x 170 ft. factory and 40 x 60 ft. office. Lockwood Greene Engrs. Inc., 100 East 42nd St., New York, N. Y., are engineers. Graybar Electric Co., 238 West First St., Charlotte, lessee.

O., Carrollton — Tuscon Rubber Co., H. Richards, Pres., is having plans prepared for the construction of a 40 x 180 ft. factory, two units. Estimated cost $100,000. Private plans. Tire making machinery will be required.

O., Cleveland—Ohio Chemical & Mfg. Co., J. G. Sholer, Pres., East 55th St. and Marquette Rd., awarded contract for a 1 story, 53 x 77 ft. addition to factory to A. M. Higley Co., Plymouth Bldg. Estimated cost $40,000.

O., Cuyahoga Falls—Akron Soap Co., Cuyahoga St., plans a 1 story addition to factory. Estimated cost $40,000. Private plans. New machinery, refrigerating units, etc. will be required.

Pa., Philadelphia—Linear Packing & Rubber Co., State Rd. and Lenck St., awarded contract for a 2 story, 46 x 128 ft. addition to factory to Wintz Bros., 1618 Sellers St. Estimated cost $60,000.

W. Va., Wellsburg—Harvey Paper Bag Co., subsidiary of Pillsburg Flour Co., awarded contract for the construction of a 1 story factory. Estimated cost $50,000.

Ont., Toronto — Aluminum Co. of Canada, 158 Sterling Rd., awarded contract for the construction of a 1 story addition to factory on Sterling Rd., to A. R. Holmes Ltd., 6 Hayden St. Estimated cost $75,000.